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# HUMAN BIOLOGY

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# ON THE RELATIONSHIP BETWEEN MENARCHEAL AGE AND CERTAIN MEASUREMENTS OF PHYSIQUE IN GIRLS OF THE AGES 9 TO 16 YEARS[1]

BY CALVIN P. STONE AND ROGER G. BARKER
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IN A previous paper (1) data have been presented which indicate that college women in whom the menarche occurs at an early age tend, on the average, to be slightly shorter and heavier than those in whom it occurs relatively late. These relations are not entirely in accord with those which exist during the early phases of adolesence, when girls with early menarcheal ages are, on the average, both taller and heavier than those with late menarcheal ages (2). These facts suggest that from late childhood to adult life changes in the relationships between menarcheal age and physique occur and that their nature may vary with chronological age.

In the present paper data are presented on the following topics: (1) a comparison of the physical development of pubescent[2] and non-

[1]Financed by a grant from the Committee for Research on Problems of Sex, National Research Council, and the Thomas Welton Stanford Funds for Psychological Research. This is a portion of a larger study now in progress which deals with differences between the attitudes and interests of pubescent and non-pubescent girls of junior high school ages.

[2]In this paper the terms pubescent and non-pubescent will be used interchangeably with the terms postmenarcheal and premenarcheal in order to avoid cumbersome phrases resulting from using the latter as adjectives.

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pubescent girls of the same ages, the ages ranging between 10½ and 16 years; (2) the physical development of girls, of the ages 12 to 16, who have been pubescent one year or less as contrasted with those who have been pubescent more than one year; and (3) the physical development of girls before the onset of the menses, ages ranging from 8½ to 13½ years, contrasting those who will become pubescent at a relatively early age with those who will become pubescent at a relatively late age. The data presented both confirm and supplement conclusions recently published by Boas (2), Flory (3), and Pryor (4).

## I. THE COMPARATIVE HEIGHT, WEIGHT, BI-ILIAC DIAMETER AND CHEST WIDTH OF PUBESCENT AND NON-PUBESCENT GIRLS OF THE SAME AGES

The data consist of measures of height, weight, bi-iliac diameter, and chest width at the level of the nipple made by our trained assistants upon 1731 California girls of junior high school age. All girls of two junior high schools in Berkeley, two junior high schools in San José, and of the seventh, eighth, and ninth grades in Redwood City were examined. Chronological ages ranged from 10 years 7 months to 15 years 12 months. Measurements on negroes, orientals, and south Europeans were discarded. Those presented are from typical middle class Caucasians of American birth.

The assistants ascertained for each individual whether or not the menarche had been reached and, if so, the age at the time of first mensis. Care was exercised by the examiner to obtain the correct year and month by asking the pupil to relate it to some easily recalled landmark such as the school class, the season of the year, or to some experience that was well established in its relation to chronological age. In certain cases, the mother of the child was asked to cooperate in determining the menarcheal age.

The distributions of measurements, grouped by six-month age intervals and according to pubescent status, are given in Tables 1 to 4. At each of the five six-month age intervals between 145 and 174 months there is a sufficient number of cases in both groups to warrant the use of ordinary tests of the significance of the difference between means. Table 5 shows that in the case of weight, chest width, and bi-iliac diameter, the means of the pubescent group are significantly higher at all of the ages involved. Inspection of Tables 2, 3, and 4 suggests also that differences of the same kind probably hold for other ages reported but for which the numbers of cases are insufficient for

## TABLE 1

*Heights of pubescent and non-pubescent girls grouped by six-month age intervals*

| AGE IN MONTHS | PUB. OR NON-PUB. | HEIGHT (*inches*) | | | | | | | | | | | *N* | *M* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 48 | 50 | 52 | 54 | 56 | 58 | 60 | 62 | 64 | 66 | 68 | | |
| 127— | P | .. | .. | .. | .. | .. | .. | .. | .. | .. | 1 | .. | 1 | 67.00 |
| 132 | NP | .. | .. | .. | 2 | 1 | 1 | 1 | .. | .. | .. | .. | 5 | 57.40 |
| 133— | P | .. | .. | 1 | .. | .. | .. | 2 | .. | .. | .. | .. | 3 | 58.34 |
| 138 | NP | .. | 2 | 3 | 3 | 8 | 9 | 4 | 1 | .. | .. | .. | 30 | 57.34 |
| 139— | P | .. | .. | .. | .. | .. | 1 | 2 | 6 | 3 | .. | .. | 12 | 62.82 |
| 144 | NP | .. | .. | 2 | 6 | 22 | 19 | 14 | 3 | 1 | .. | .. | 67 | 58.50 |
| 145— | P | .. | .. | .. | .. | .. | 7 | 17 | 11 | 9 | 1 | 1 | 46 | 62.26 |
| 150 | NP | 1 | .. | 3 | 11 | 37 | 45 | 42 | 28 | 4 | 2 | 1 | 174 | 59.58 |
| 151— | P | .. | .. | 1 | .. | 1 | 9 | 24 | 42 | 27 | 7 | .. | 111 | 62.82 |
| 156 | NP | .. | 1 | .. | 5 | 21 | 32 | 44 | 28 | 12 | 2 | .. | 145 | 60.50 |
| 157— | P | .. | .. | .. | .. | 2 | 14 | 44 | 54 | 40 | 15 | 1 | 170 | 62.94 |
| 162 | NP | .. | .. | .. | 3 | 7 | 16 | 33 | 26 | 13 | 3 | .. | 101 | 61.42 |
| 163— | P | .. | .. | .. | .. | 1 | 15 | 25 | 62 | 53 | 27 | 6 | 189 | 63.70 |
| 168 | NP | .. | .. | .. | .. | 5 | 14 | 22 | 18 | 11 | 2 | 1 | 73 | 61.72 |
| 169— | P | .. | .. | .. | .. | 3 | 17 | 41 | 62 | 77 | 29 | 4 | 233 | 63.54 |
| 174 | NP | .. | .. | .. | 1 | 4 | 5 | 10 | 17 | 8 | 4 | .. | 49 | 62.18 |
| 175— | P | .. | .. | .. | .. | .. | 8 | 23 | 77 | 79 | 26 | 8 | 221 | 64.04 |
| 180 | NP | .. | .. | .. | .. | .. | 2 | 4 | 8 | 5 | 2 | 2 | 23 | 63.60 |
| 181— | P | .. | .. | .. | .. | .. | 1 | 15 | 13 | 12 | 6 | 5 | 52 | 63.84 |
| 186 | NP | .. | .. | .. | .. | .. | .. | .. | 2 | 1 | 1 | .. | 4 | 64.50 |
| 187— | P | .. | .. | .. | .. | .. | 1 | 6 | 6 | 2 | 3 | .. | 18 | 63.00 |
| 192 | NP | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... | .... |

tests of significance to be used. On the average, pubescent girls are from 14.10 to 19.01 pounds heavier than non-pubescent girls; their bi-iliac diameters are from 1.23 to 1.63 centimeters greater; and their chests are from 0.82 to 1.38 centimeters broader.

The greater size of the pubescent girls may be stated in terms of the time required for non-pubescent girls to grow in size an equal amount; i.e., in terms of non-pubescent growth years. In these terms

TABLE 2

*Weights of pubescent and non-pubescent girls grouped by six-month age intervals*

| AGE IN MONTHS | PUB. OR NON-PUB. | WEIGHT (*pounds*) 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 | *N* | *M* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 127— | P | .. | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | .. | 1 | 135.00 |
| 132 | NP | 1 | 1 | 1 | 1 | 1 | .. | .. | .. | .. | .. | .. | .. | 5 | 85.00 |
| 133— | P | .. | .. | 1 | 1 | .. | .. | .. | 1 | .. | .. | .. | .. | 3 | 105.00 |
| 138 | NP | 5 | 8 | 4 | 7 | 4 | 2 | .. | .. | .. | .. | .. | .. | 30 | 86.00 |
| 139— | P | .. | .. | .. | 1 | 2 | 5 | 3 | 1 | .. | .. | .. | .. | 12 | 115.83 |
| 144 | NP | 5 | 18 | 15 | 14 | 9 | 4 | 1 | .. | 1 | .. | .. | .. | 67 | 94.10 |
| 145— | P | .. | .. | .. | 10 | 9 | 16 | 7 | 3 | 1 | .. | .. | .. | 46 | 112.17 |
| 150 | NP | 6 | 28 | 41 | 49 | 36 | 6 | 3 | 2 | 2 | .. | .. | 1 | 174 | 93.16 |
| 151— | P | .. | .. | 1 | 18 | 31 | 28 | 14 | 7 | 7 | 3 | .. | 2 | 111 | 115.27 |
| 156 | NP | 4 | 13 | 41 | 34 | 19 | 26 | 6 | 2 | .. | .. | .. | .. | 145 | 99.27 |
| 157— | P | .. | 1 | 7 | 21 | 48 | 29 | 37 | 11 | 9 | 4 | 1 | 2 | 170 | 115.23 |
| 162 | NP | 1 | 6 | 19 | 27 | 20 | 14 | 10 | 2 | 2 | .. | .. | .. | 101 | 101.13 |
| 163— | P | .. | 1 | 5 | 24 | 35 | 59 | 30 | 16 | 11 | 5 | 2 | 2 | 190 | 116.84 |
| 168 | NP | .. | 6 | 12 | 20 | 15 | 9 | 8 | 1 | .. | 2 | .. | .. | 73 | 101.71 |
| 169— | P | .. | .. | 3 | 30 | 59 | 62 | 49 | 15 | 7 | 5 | .. | 3 | 233 | 115.43 |
| 174 | NP | .. | 4 | 10 | 18 | 10 | 2 | 3 | 2 | .. | .. | .. | .. | 49 | 97.65 |
| 175— | P | .. | .. | 3 | 23 | 43 | 55 | 55 | 23 | 11 | 3 | 4 | 3 | 223 | 118.86 |
| 180 | NP | .. | 1 | 2 | 11 | 6 | 2 | .. | 1 | .. | .. | .. | .. | 23 | 99.35 |
| 181— | P | .. | .. | .. | 6 | 13 | 12 | 11 | 4 | .. | 1 | 2 | 3 | 52 | 120.00 |
| 186 | NP | .. | .. | .. | 1 | 1 | .. | 1 | 1 | .. | .. | .. | .. | 4 | 115.00 |
| 187— | P | .. | .. | 1 | 3 | 4 | 2 | 6 | 1 | 1 | .. | .. | .. | 18 | 113.89 |
| 192 | NP | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... | ..... |

pubescent girls average from 3½ to 4½ growth years heavier, from 2½ to 3 growth years broader in bi-iliac diameter, and from 2 to 3 growth years broader in chest width than non-pubescent girls.

Height presents a slightly different situation. Tables 1 and 5 show that with advancing age, the superiority of pubescent girls over non-pubescents gradually decreases. For the age interval 175—180 months the difference becomes statistically insignificant (critical ratio is 0.76).

## TABLE 3

*Bi-iliac diameters of pubescent and non-pubescent girls grouped by six-month age intervals*

| AGE IN MONTHS | PUB. OR NON-PUB. | BI-ILIAC DIAMETERS (*cm*) | | | | | | | | | | | | *N* | *M* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | | |
| 127— | P | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | .. | .. | 1 | 26.500 |
| 132 | NP | .. | .. | 2 | 1 | .. | 2 | .. | .. | .. | .. | .. | .. | 5 | 23.900 |
| 133— | P | .. | .. | .. | 1 | .. | 2 | .. | .. | .. | .. | .. | .. | 3 | 24.833 |
| 138 | NP | 2 | 4 | 5 | 4 | 7 | 5 | 2 | 1 | .. | .. | .. | .. | 30 | 23.767 |
| 139— | P | .. | .. | .. | .. | 1 | 1 | 4 | 6 | .. | .. | .. | .. | 12 | 26.750 |
| 144 | NP | 1 | 6 | 10 | 13 | 15 | 12 | 6 | 2 | 2 | .. | .. | .. | 67 | 24.246 |
| 145— | P | .. | .. | 1 | 2 | 4 | 16 | 9 | 10 | 3 | .. | .. | 1 | 46 | 26.217 |
| 150 | NP | 1 | 6 | 22 | 35 | 35 | 49 | 19 | 4 | .. | 2 | .. | 1 | 174 | 25.586 |
| 151— | P | .. | .. | 2 | 2 | 12 | 22 | 33 | 19 | 11 | 5 | 2 | 2 | 110 | 26.627 |
| 156 | NP | 2 | .. | 8 | 29 | 27 | 40 | 27 | 9 | 3 | .. | .. | .. | 145 | 25.052 |
| 157— | P | .. | 1 | .. | 9 | 7 | 35 | 48 | 36 | 23 | 5 | 5 | 1 | 170 | 26.741 |
| 162 | NP | .. | 1 | 5 | 10 | 20 | 30 | 17 | 12 | 5 | 1 | .. | .. | 101 | 25.510 |
| 163— | P | .. | .. | .. | 2 | 17 | 27 | 52 | 43 | 29 | 16 | 4 | 1 | 191 | 27.039 |
| 168 | NP | .. | 1 | 3 | 9 | 13 | 20 | 15 | 8 | 3 | .. | 1 | .. | 73 | 25.514 |
| 169— | P | .. | .. | 2 | .. | 11 | 46 | 60 | 56 | 35 | 20 | 3 | .. | 233 | 27.024 |
| 174 | NP | .. | .. | .. | 6 | 9 | 17 | 9 | 6 | 1 | 1 | .. | .. | 49 | 25.643 |
| 175— | P | .. | .. | .. | .. | 9 | 33 | 51 | 63 | 43 | 14 | 7 | 3 | 223 | 27.321 |
| 180 | NP | .. | .. | .. | 2 | 3 | 8 | 7 | 3 | .. | .. | .. | .. | 23 | 25.761 |
| 181— | P | .. | .. | .. | .. | .. | 7 | 15 | 10 | 12 | 3 | 2 | 3 | 52 | 27.634 |
| 186 | NP | .. | .. | .. | .. | .. | .. | 2 | 1 | .. | 1 | .. | .. | 4 | 27.500 |
| 187— | P | .. | .. | .. | 1 | 1 | 1 | 4 | 6 | 3 | 2 | .. | .. | 18 | 27.167 |
| 192 | NP | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... | ..... |

Data on university women previously published (1) suggest that at later ages the mean height of late pubescent girls equals and, finally, at the terminal stage of growth, slightly surpasses that of early pubescents.

The problem of growth in pre- and post-menarcheal aged girls has been approached by use of regression lines which, together with the obtained means, are shown in figure 1. The regression coefficients are given in Table 6. In all cases a straight line adequately represents

## TABLE 4

*Chest widths of pubescent and non-pubescent girls grouped by six-month age intervals*

| AGE IN MONTHS | PUB. OR NON-PUB. | CHEST WIDTH (*cm*) 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | *N* | *M* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 127— | P | .. | .. | .. | .. | .. | .. | .. | 1 | .. | .. | .. | .. | 1 | 26.500 |
| 132 | NP | 2 | .. | 1 | 1 | .. | .. | 1 | .. | .. | .. | .. | .. | 5 | 21.700 |
| 133— | P | .. | .. | .. | 1 | .. | 1 | 1 | .. | .. | .. | .. | .. | 3 | 24.167 |
| 138 | NP | 3 | 9 | 6 | 4 | 3 | 3 | 1 | .. | 1 | .. | .. | .. | 30 | 21.967 |
| 139— | P | .. | .. | .. | .. | 3 | 4 | 5 | .. | .. | .. | .. | .. | 12 | 24.667 |
| 144 | NP | 3 | 7 | 14 | 20 | 9 | 9 | 4 | 1 | .. | .. | .. | .. | 67 | 22.590 |
| 145— | P | .. | .. | .. | 4 | 12 | 14 | 11 | 4 | 1 | .. | .. | .. | 46 | 24.543 |
| 150 | NP | 4 | 15 | 19 | 38 | 49 | 29 | 15 | 3 | 1 | .. | .. | 1 | 174 | 23.167 |
| 151— | P | .. | .. | 1 | 14 | 28 | 26 | 26 | 13 | 1 | 2 | 1 | .. | 112 | 24.580 |
| 156 | NP | 1 | 6 | 24 | 41 | 28 | 28 | 12 | 5 | .. | .. | .. | .. | 145 | 23.197 |
| 157— | P | .. | .. | 5 | 12 | 38 | 53 | 33 | 17 | 7 | 5 | .. | .. | 170 | 24.682 |
| 162 | NP | 1 | 1 | 11 | 19 | 26 | 23 | 16 | 2 | 2 | .. | .. | .. | 101 | 23.708 |
| 163— | P | .. | 1 | 2 | 20 | 32 | 50 | 53 | 24 | 5 | 3 | .. | .. | 190 | 24.742 |
| 168 | NP | .. | 1 | 6 | 15 | 19 | 14 | 10 | 5 | 3 | .. | .. | .. | 73 | 23.925 |
| 169— | P | .. | 1 | 4 | 9 | 42 | 78 | 60 | 20 | 12 | 7 | .. | .. | 233 | 24.878 |
| 174 | NP | .. | .. | 6 | 15 | 6 | 12 | 4 | 5 | 1 | .. | .. | .. | 49 | 23.745 |
| 175— | P | .. | .. | 1 | 14 | 49 | 56 | 46 | 34 | 13 | 5 | 4 | 1 | 223 | 25.034 |
| 180 | NP | .. | .. | 1 | 4 | 4 | 10 | 2 | 2 | .. | .. | .. | .. | 23 | 24.109 |
| 181— | P | .. | .. | .. | 1 | 9 | 16 | 13 | 7 | 1 | 3 | 2 | .. | 52 | 25.288 |
| 186 | NP | .. | .. | .. | 2 | .. | 1 | .. | .. | 1 | .. | .. | .. | 4 | 24.250 |
| 187— | P | .. | .. | 1 | 1 | 2 | 6 | 6 | 1 | .. | 1 | .. | .. | 18 | 24.778 |
| 192 | NP | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | ... | ..... |

the means for this age range. From an inspection of the regression lines and their coefficients, it is apparent that the means of the non-pubescent girls are increasing with chronological age more rapidly than those of the pubescent girls. Critical ratios given in Table 6 indicate that the differences in slopes of the regression lines approach significance in all cases. The regression lines for height are the only ones that meet in the age periods studied. This is in accord with our findings

## TABLE 5

*Differences in mean physical measurements of pubescent and non-pubescent girls of the same age*

| AGE | $M_{Pub.}-M_{Non-pub.}$ | DIFFERENCE | $M_{Pub.}-M_{Non-pub.}$ | DIFFERENCE $\sigma_{diff.}$ |
|---|---|---|---|---|
| | Weight (*pounds*) | | Height (*inches*) | |
| 145-150 | 19.01 | 8.56 | 2.68 | 6.70 |
| 151-156 | 16.00 | 6.98 | 2.32 | 7.16 |
| 157-162 | 14.10 | 6.71 | 1.52 | 4.78 |
| 163-168 | 15.13 | 6.38 | 1.98 | 6.92 |
| 169-174 | 17.78 | 7.80 | 1.36 | 3.09 |
| | Chest width (*cm.*) | | Bi-iliac diameter (*cm.*) | |
| 145-150 | 1.38 | 6.52 | 1.63 | 6.32 |
| 151-156 | 1.38 | 7.56 | 1.58 | 7.77 |
| 157-162 | 0.97 | 5.26 | 1.23 | 6.31 |
| 163-168 | 0.82 | 3.87 | 1.52 | 6.96 |
| 169-174 | 1.13 | 4.61 | 1.38 | 6.42 |

## TABLE 6

*Regression coefficients of height, weight, bi-iliac diameter, and chest width upon chronological age in pubescent and non-pubescent girls*

| | PUBESCENT | | NON-PUBESCENT | | NON. PUB.-PUB. |
|---|---|---|---|---|---|
| | $b$ | $\sigma_b$ | $b$ | $\sigma_b$ | $\sigma_{diff.}$ |
| Height ..... | .042 | .005 | .133 | .009 | 9.1 |
| Weight ..... | .127 | .051 | .388 | .057 | 3.4 |
| Bi-iliac ..... | .029 | .005 | .052 | .006 | 2.9 |
| Chest Width ..... | .016 | .004 | .045 | .006 | 4.0 |

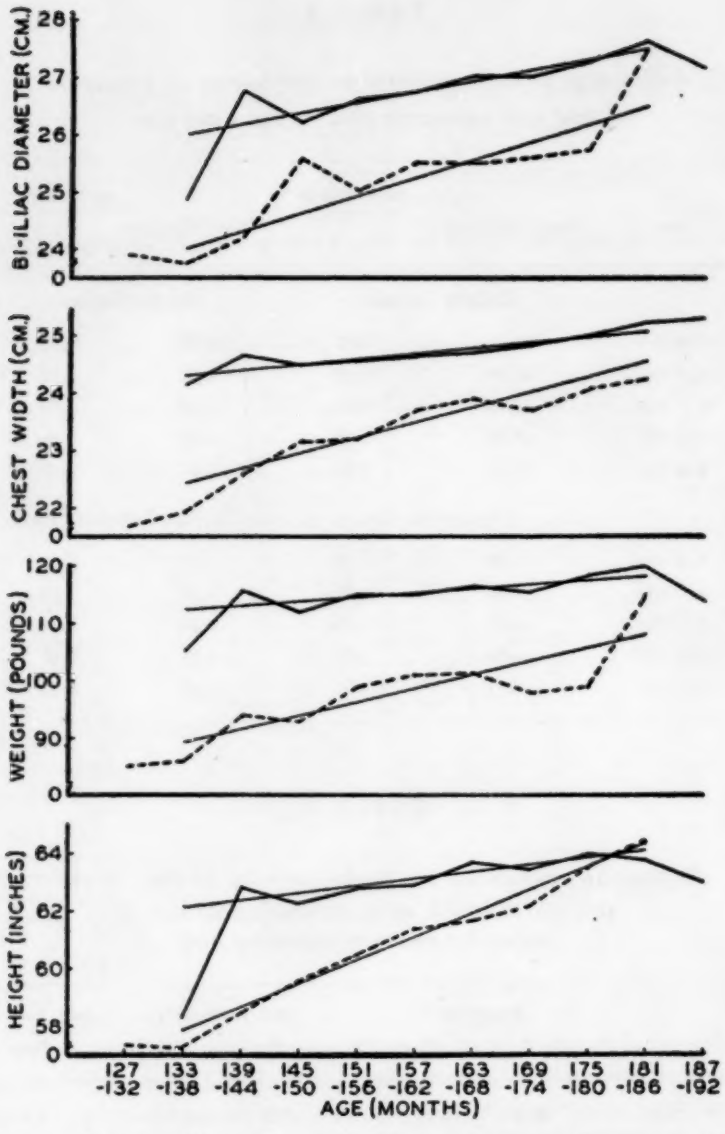


FIG. 1. OBTAINED MEAN PHYSICAL MEASUREMENTS OF PUBESCENT (SOLID LINE) AND NON-PUBESCENT (DASH LINE) GIRLS; BEST FIT STRAIGHT REGRESSION LINES.

for university women(1). In the late adolescent years it was found that the regression lines cross and that the late maturing women are relatively the taller. This appears to be the terminal situation. In the case of weight, however, the early maturing girls are, at seventeen years, still the heavier, but by twenty and twenty-one years both groups are of the same average weight. This, also, appears to be the terminal situation (1).

In this connection it is of interest to note that if the means of the combined pubescent and non-pubescent groups are plotted, the usual growth curve for this period results. This suggests that the familiar sharp rise in the height and weight curves which typically occurs prior to and just after the time of the menarche (4) may be primarily a function of the increasing incidence of those undergoing the pubescent spurt in growth rate.

### 2. HEIGHT, WEIGHT, BI-ILIAC DIAMETER AND CHEST WIDTH IN RELATION TO LENGTH OF TIME PUBESCENT AND TO MENARCHEAL AGE

The relationship between physical measurements and menarcheal age in the period after the onset of the menses will next be considered. The data for pubescent individuals in each age group have been subdivided into two groups: (1) those who have been pubescent one year or less, and (2) those who have been pubescent more than one year. The number of individuals available hardly warrants further subdivision, but this would be desirable if additional cases were at hand. The data for these two groups of pubescent girls, distributed by chronological ages, are given in Tables 7 to 10. The significances of the differences between the means for five age groups are given in Table 11; the regression coefficients are shown in Table 12; and the regression lines and obtained means in Figure 2. While considering the differences between these groups the reader should keep in mind the following points: (1) when chronological age is kept constant and length of time since the menarche varied, menarcheal age is necessarily varied also; (2) when chronological age is varied and the time since the menarche is held constant, menarcheal age is necessarily varied; (3) for the group which has been pubescent one year or less the duration of pubescence at each chronological age averages approximately six months; (4) for the group that has been pubescent more than one year there is, with advancing chronological age, an increase in the mean number of months since the time of the first mensis; in this latter

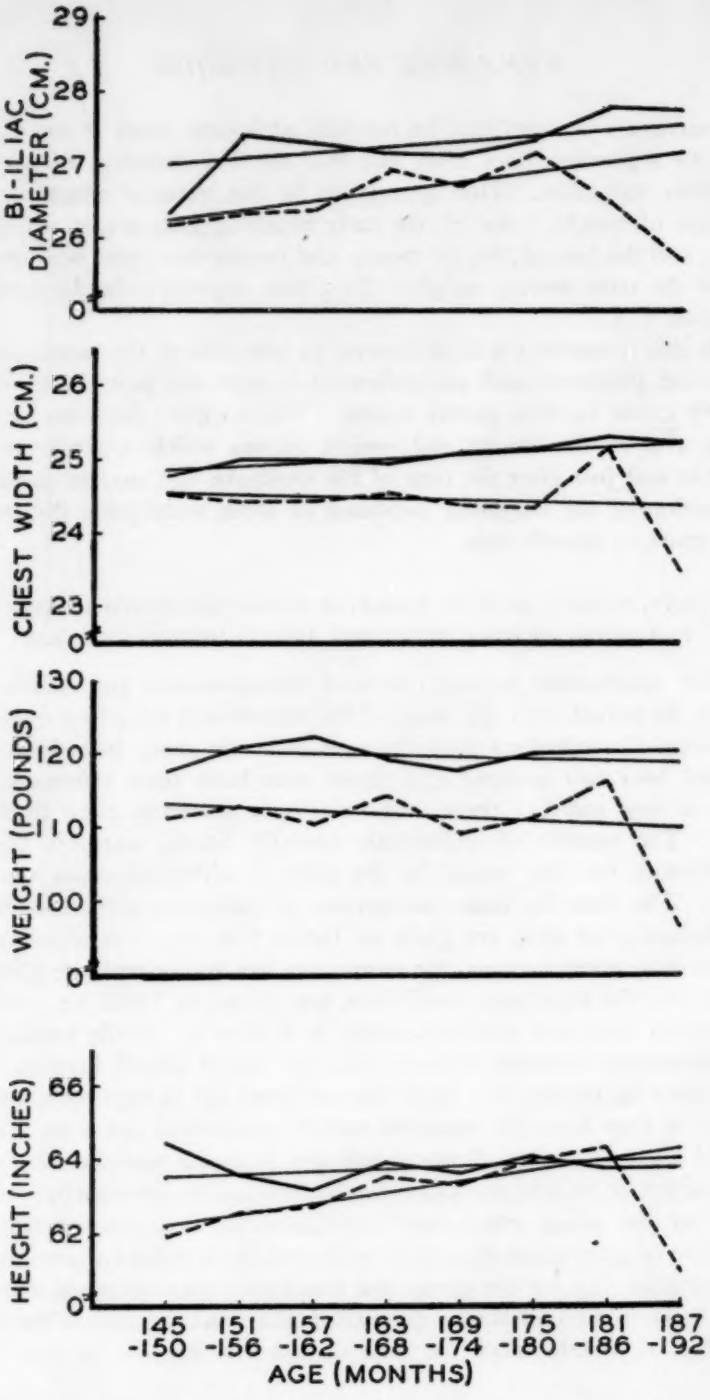


FIG. 2. OBTAINED MEAN PHYSICAL MEASUREMENTS OF GIRLS WHO HAVE BEEN PUBESCENT ONE YEAR OR LESS (DASH LINE) AND OF GIRLS WHO HAVE BEEN PUBESCENT MORE THAN ONE YEAR (SOLID LINE); BEST FIT STRAIGHT REGRESSION LINES.

## TABLE 7

*Heights of girls (1) pubescent one year or less and (2) pubescent more than one year, grouped by six-month age intervals*

| AGE IN MONTHS | PUB. GROUP | HEIGHT (*inches*) 52 | 54 | 56 | 58 | 60 | 62 | 64 | 66 | 68 | *N* | *M* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 145— | 1 | .. | .. | .. | 7 | 16 | 10 | 5 | .. | 1 | 39 | 61.88 |
| 150 | 2 | .. | .. | .. | .. | 1 | 1 | 4 | 1 | .. | 7 | 64.42 |
| 151— | 1 | 1 | .. | 1 | 7 | 22 | 28 | 16 | 5 | .. | 80 | 62.56 |
| 156 | 2 | .. | .. | .. | 2 | 2 | 14 | 11 | 2 | .. | 31 | 63.58 |
| 157— | 1 | .. | .. | 1 | 9 | 30 | 33 | 24 | 6 | 1 | 104 | 62.76 |
| 162 | 2 | .. | .. | 1 | 5 | 14 | 21 | 16 | 9 | .. | 66 | 63.22 |
| 163— | 1 | .. | .. | 1 | 8 | 15 | 34 | 21 | 14 | 4 | 97 | 63.56 |
| 168 | 2 | .. | .. | .. | 7 | 10 | 28 | 32 | 13 | 2 | 92 | 63.86 |
| 169— | 1 | .. | .. | .. | 5 | 17 | 21 | 20 | 7 | 2 | 72 | 63.36 |
| 174 | 2 | .. | .. | 3 | 12 | 24 | 41 | 57 | 22 | 2 | 161 | 63.62 |
| 175— | 1 | .. | .. | .. | 2 | 2 | 14 | 16 | 3 | 1 | 38 | 64.00 |
| 180 | 2 | .. | .. | .. | 6 | 21 | 63 | 63 | 23 | 7 | 183 | 64.06 |
| 181— | 1 | .. | .. | .. | .. | 2 | .. | 3 | .. | 1 | 6 | 64.33 |
| 186 | 2 | .. | .. | .. | 1 | 13 | 13 | 9 | 6 | 4 | 46 | 63.78 |
| 187— | 1 | .. | .. | .. | 1 | 3 | 1 | .. | .. | .. | 5 | 61.00 |
| 192 | 2 | .. | .. | .. | .. | 3 | 5 | 2 | 3 | .. | 13 | 63.76 |

group, therefore, there is a progressive increase in the mean duration of pubescence, whereas in the former the mean duration remains relatively constant. These inter-relationships greatly complicate the task of determining causal factors.

Tables 7 to 11 indicate that, in general, the measurements for girls who have been pubescent more than one year are greater than those of the same ages who have been pubescent one year or less. Although, as shown in Table 11, reliabilities of the differences vary with each measure and at particular ages some of the differences are not signifi-

## TABLE 8

*Weights of girls (1) pubescent one year or less and (2) pubescent more than one year, grouped by six-month age intervals*

| AGE IN MONTHS | PUB. GROUP | WEIGHT (*pounds*) | | | | | | | | | | | *N* | *M* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 | | |
| 145— | 1 | .. | .. | 9 | 8 | 15 | 4 | 2 | 1 | .. | .. | .. | 39 | 111.1 |
| 150 | 2 | .. | .. | 1 | 1 | 1 | 3 | 1 | .. | .. | .. | .. | 7 | 117.8 |
| 151— | 1 | .. | 1 | 14 | 25 | 22 | 8 | 3 | 4 | 2 | .. | 1 | 80 | 113.0 |
| 156 | 2 | .. | .. | 4 | 6 | 6 | 6 | 4 | 3 | 1 | .. | 1 | 31 | 121.1 |
| 157— | 1 | 1 | 7 | 15 | 35 | 21 | 17 | 1 | 4 | 2 | 1 | .. | 104 | 110.6 |
| 162 | 2 | .. | .. | 6 | 13 | 8 | 20 | 10 | 5 | 2 | .. | 2 | 66 | 122.6 |
| 163— | 1 | 1 | 5 | 12 | 19 | 31 | 16 | 6 | 4 | 1 | 1 | 1 | 97 | 114.3 |
| 168 | 2 | .. | .. | 12 | 16 | 28 | 14 | 10 | 7 | 4 | 1 | 1 | 93 | 119.5 |
| 169— | 1 | .. | 2 | 17 | 20 | 21 | 7 | 3 | 2 | .. | .. | .. | 72 | 109.3 |
| 174 | 2 | .. | 1 | 13 | 39 | 41 | 42 | 12 | 5 | 5 | .. | 3 | 161 | 118.2 |
| 175— | 1 | .. | 1 | 7 | 11 | 9 | 5 | 5 | .. | .. | .. | .. | 38 | 111.6 |
| 180 | 2 | .. | 2 | 16 | 32 | 46 | 50 | 18 | 11 | 3 | 4 | 3 | 185 | 120.3 |
| 181— | 1 | .. | .. | 1 | 2 | 2 | .. | .. | .. | .. | 1 | .. | 6 | 116.6 |
| 186 | 2 | .. | .. | 5 | 11 | 10 | 11 | 4 | .. | 1 | 1 | 3 | 46 | 120.4 |
| 187— | 1 | .. | 1 | 2 | 2 | .. | .. | .. | .. | .. | .. | .. | 5 | 97.0 |
| 192 | 2 | .. | .. | 1 | 2 | 2 | 6 | 1 | 1 | .. | .. | .. | 13 | 120.4 |

cant, nevertheless, when one considers the consistency in the trends throughout these independent samples there can be little doubt that the differences are real. Whether these obtained differences should be attributed to the effects of the differences in length of time pubescent or to the differences in menarcheal ages cannot be determined from the present data.

Measurements of physique in relation to chronological age in the foregoing groups are further elucidated by the regression coefficients in Table 12 and the regression lines in Figure 2. Let us first consider

TABLE 9

*Bi-iliac diameters of girls (1) pubescent one year or less and (2) pubescent more than one year, grouped by six-month age intervals*

| AGE IN MONTHS | PUB. GROUP | BI-ILIAC DIAMETER (*cm*) | | | | | | | | | | | *N* | *M* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | | |
| 145— | 1 | .. | 1 | 2 | 2 | 15 | 8 | 8 | 2 | .. | .. | 1 | 39 | 26.19 |
| 150 | 2 | .. | .. | .. | 2 | 1 | 1 | 2 | 1 | .. | .. | .. | 7 | 26.35 |
| 151— | 1 | .. | 1 | 2 | 12 | 15 | 26 | 15 | 6 | 1 | .. | 1 | 79 | 26.32 |
| 156 | 2 | .. | 1 | .. | .. | 7 | 7 | 4 | 5 | 4 | 2 | 1 | 31 | 27.40 |
| 157— | 1 | 1 | .. | 7 | 6 | 26 | 29 | 21 | 11 | 3 | .. | .. | 104 | 26.38 |
| 162 | 2 | .. | .. | 2 | 1 | 9 | 19 | 15 | 12 | 2 | 5 | 1 | 66 | 27.30 |
| 163— | 1 | .. | .. | 1 | 12 | 11 | 32 | 19 | 11 | 8 | 3 | .. | 97 | 26.90 |
| 168 | 2 | .. | .. | 1 | 5 | 16 | 20 | 24 | 18 | 8 | 1 | 1 | 94 | 27.18 |
| 169— | 1 | .. | 2 | .. | 5 | 14 | 19 | 21 | 7 | 4 | .. | .. | 72 | 26.71 |
| 174 | 2 | .. | .. | .. | 6 | 32 | 41 | 35 | 28 | 16 | 3 | .. | 161 | 27.16 |
| 175— | 1 | .. | .. | .. | 2 | 5 | 9 | 14 | 5 | 2 | 1 | .. | 38 | 27.16 |
| 180 | 2 | .. | .. | .. | 7 | 28 | 42 | 49 | 38 | 12 | 6 | 3 | 185 | 27.35 |
| 181— | 1 | .. | .. | .. | .. | 3 | 1 | 1 | 1 | .. | .. | .. | 6 | 26.50 |
| 186 | 2 | .. | .. | .. | .. | 4 | 14 | 9 | 11 | 3 | 2 | 3 | 46 | 27.78 |
| 187— | 1 | .. | .. | 1 | 1 | 1 | 1 | .. | 1 | .. | .. | .. | 5 | 25.70 |
| 192 | 2 | .. | .. | .. | .. | .. | 3 | 6 | 2 | 2 | .. | .. | 13 | 27.73 |

the data for girls who have been pubescent one year or less. Here the situation is least complex because length of time since the menarche is held relatively constant and only menarcheal age is varied. Upon referring to the regression lines of Figure 2 and the appropriate regression coefficients of Table 12 one observes that in the case of weight and chest-width there is no evidence that the older girls of this age range are heavier or broader than the younger girls. This is a remarkable fact, for it has been demonstrated by comparisons of pubescent and non-pubescent girls of the same chronological ages (cf. tables

## TABLE 10

*Chest widths of girls (1) pubescent one year or less and (2) pubescent more than one year, grouped by six-month age intervals*

| AGE IN MONTHS | PUB. GROUP | CHEST WIDTH (*cm*) | | | | | | | | | | | *N* | *M* |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 | 30 | | |
| 145— | 1 | .. | .. | 3 | 10 | 13 | 10 | 3 | .. | .. | .. | .. | 39 | 24.50 |
| 150 | 2 | .. | .. | 1 | 2 | 1 | 1 | 1 | 1 | .. | .. | .. | 7 | 24.78 |
| 151— | 1 | .. | 1 | 12 | 20 | 21 | 19 | 6 | .. | 1 | 1 | .. | 81 | 24.41 |
| 156 | 2 | .. | .. | 2 | 8 | 5 | 7 | 7 | 1 | 1 | .. | .. | 31 | 25.02 |
| 157— | 1 | .. | 4 | 11 | 25 | 32 | 18 | 8 | 4 | 2 | .. | .. | 104 | 24.45 |
| 162 | 2 | .. | 1 | 1 | 13 | 21 | 15 | 9 | 3 | 3 | .. | .. | 66 | 25.05 |
| 163— | 1 | 1 | 1 | 14 | 16 | 28 | 25 | 8 | 2 | 2 | .. | .. | 97 | 24.54 |
| 168 | 2 | .. | 1 | 6 | 16 | 22 | 28 | 16 | 3 | 1 | .. | .. | 93 | 24.95 |
| 169— | 1 | .. | 4 | 4 | 20 | 21 | 17 | 4 | 2 | .. | .. | .. | 72 | 24.38 |
| 174 | 2 | 1 | .. | 5 | 22 | 57 | 43 | 16 | 10 | 7 | .. | .. | 161 | 25.10 |
| 175— | 1 | .. | 1 | 2 | 14 | 11 | 6 | 3 | .. | 1 | .. | .. | 38 | 24.37 |
| 180 | 2 | .. | .. | 12 | 35 | 45 | 40 | 31 | 13 | 4 | 4 | 1 | 185 | 25.17 |
| 181— | 1 | .. | .. | .. | 1 | 2 | 1 | 2 | .. | .. | .. | .. | 6 | 25.17 |
| 186 | 2 | .. | .. | 1 | 8 | 14 | 12 | 5 | 1 | 3 | 2 | .. | 46 | 25.30 |
| 187— | 1 | .. | 1 | 1 | 1 | 1 | 1 | .. | .. | .. | .. | .. | 5 | 23.50 |
| 192 | 2 | .. | .. | .. | 1 | 5 | 5 | 1 | .. | 1 | .. | .. | 13 | 25.27 |

that precede and those that follow this discussion) that when these sixteen year old girls were twelve years of age and non-pubescent they were, on the average, significantly smaller than the twelve year old pubescent girls represented in Figure 2. With four years of relatively slow but continuous growth plus a spurt in growth that immediately precedes and follows the menarche (4) they have just attained mean weights and chest-widths equal to those who were pubescent approximately four years earlier. In the case of height and bi-iliac diameter, however, one finds rather clear evidence that the older girls who have

## TABLE 11

*Differences in mean physical measurements (1) of girls who have been pubescent one year or less and (2) of girls who have been pubescent more than one year*

| AGE (*months*) | $M_2 - M_1$ | DIFFERENCE / $\sigma_{diff.}$ | $M_2 - M_1$ | DIFFERENCE / $\sigma_{diff.}$ |
|---|---|---|---|---|
| | Weight (*pounds*) | | Height (*inches*) | |
| 151-156 | 8.13 | 2.11 | 1.02 | 2.41 |
| 157-162 | 12.00 | 4.44 | 0.46 | 1.25 |
| 163-168 | 5.24 | 2.09 | 0.30 | 0.84 |
| 169-174 | 8.86 | 4.50 | 0.26 | 0.75 |
| 175-180 | 8.77 | 3.47 | 0.06 | 0.16 |
| | Chest width (*cm.*) | | Bi-iliac diameter (*cm.*) | |
| 151-156 | 0.61 | 1.99 | 1.08 | 2.81 |
| 157-162 | 0.60 | 2.14 | 0.92 | 3.67 |
| 163-168 | 0.41 | 2.03 | 0.28 | 1.31 |
| 169-174 | 0.72 | 3.26 | 0.45 | 2.20 |
| 175-180 | 0.82 | 3.29 | 0.19 | 0.80 |

## TABLE 12

*Regression coefficients of height, weight, bi-iliac diameter, and chest width upon chronological age in (1) girls who have been pubescent one year or less and in (2) girls who have been pubescent more than one year*

| | (1) ONE YEAR OR LESS | | (2) MORE THAN ONE YEAR | |
|---|---|---|---|---|
| | $b$ | $\sigma_b$ | $b$ | $\sigma_b$ |
| Height ..... | .051 | .012 | .015 | .011 |
| Weight ..... | —.065 | .081 | —.036 | .080 |
| Bi-iliac Diameter ..... | .022 | .008 | .013 | .007 |
| Chest Width ..... | —.003 | .007 | .010 | .007 |

been pubescent one year or less are the taller and the broader. This nonconformity between relationships of menarcheal age to weight and chest-width on the one hand and to height and bi-iliac diameter on the other nicely exemplifies a point that has not received sufficient attention in studies of physique, namely, that from childhood to adult life significant changes in the relationships between menarcheal age and different measures of physique occur and that their natures and amounts may vary with chronological age.

The regressions involving the girls who have been pubescent more than one year are complicated because of the fact that with advancing chronological age both the length of time since the menarche and age at the menarche increase. The regression lines of Figure 2 and the regression coefficients of Table 12 give no clear indication that the older girls are larger in the case of height, weight and chest width, but they possibly are broader in the case of bi-iliac diameter.

### 3. RELATIONSHIPS BETWEEN HEIGHT AND WEIGHT AND THE AGE AT FIRST MENSIS IN THE YEARS BEFORE THE MENARCHE

By the use of consecutive measurements it has been possible to project backward from the age of the menarche the trends of height and weight development for some of our subjects. For all but 32 of the 488 cases measured in the junior high schools of San José we were able to obtain consecutive height and weight measurements for several of the years prior to the time of the last measurement. These data are by no means ideal for use in a scientific inquiry because they do not cover exactly the same life spans of all the pupils, because they may have been taken by different workers, and (or) because here and there a set of records is missing. Nevertheless, it appears that they are sufficiently complete to indicate the general trend of premenarcheal growth rate. They confirm and possibly extend conclusions recently reached by Boas (2).

Table 13 gives the number of individuals in the present group for whom varying numbers of consecutive semi-annual measurements are complete and also those with but one measurement missing.

In order to ascertain the relationships between pre-pubertal height and weight and the age of onset of the menses, the total group of individuals has been subdivided on the basis of menarcheal age into three sub-groups. Group 1 includes those with menarcheal ages falling between 126 and 143 months; group 2, those falling between 144 and

TABLE 13

*Number of subjects for whom varying numbers of consecutive semi-annual measures were complete, and those with one semi-annual measurement missing*

| NO. SEMI-ANNUAL MEASUREMENTS | NUMBER OF SUBJECTS | | | |
|---|---|---|---|---|
| | Consecutive measures complete | One measure missing | Total | Per cent of grand total |
| 1 | .. | .. | 32 | 6.56 |
| 2 | 90 | 15 | 105 | 21.52 |
| 3 | 8 | 46 | 54 | 11.07 |
| 4 | 24 | 26 | 50 | 10.25 |
| 5 | 6 | 19 | 25 | 5.12 |
| 6 | 21 | 16 | 37 | 7.58 |
| 7 | 20 | 15 | 35 | 7.17 |
| 8 | 10 | 14 | 24 | 4.92 |
| 9 | 29 | 14 | 43 | 8.81 |
| 10 | 18 | 4 | 22 | 4.51 |
| 11 | 19 | 6 | 25 | 5.12 |
| 12 | 19 | 1 | 20 | 4.10 |
| 13 | 8 | 1 | 9 | 1.84 |
| 14 | 5 | 0 | 5 | 1.02 |
| 15 | 0 | 1 | 1 | 0.20 |
| 16 | 1 | 0 | 1 | 0.20 |
| Totals | 308 | 178 | 488 | 100.00 |

155 months; and group 3, those falling between 156 and 179 months. For the populations from which these subjects were taken these groups denote roughly early, medium, and late menarcheal ages. In Tables 14 and 15, and in Figures 3 and 4, will be found the pertinent data for this problem. The heights and weights are distributed at half-year intervals between the ages 8½ and 13½ years.

Consider first the height and weight data for the girls with chronological ages ranging from 102 to 107 months. At this age, from 18 to 41 months will elapse before the girls of group 1 will reach the men-

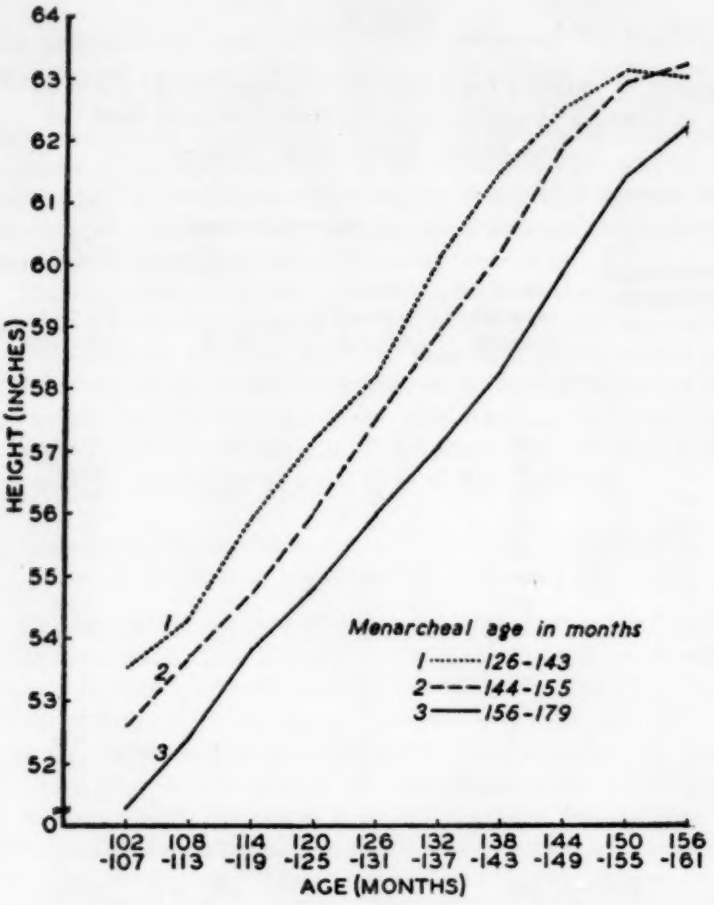


FIG. 3. GROWTH IN HEIGHT OF EARLY, MEDIUM, AND LATE PUBESCENT GIRLS.

arche; for group 2, from 37 to 53 months will elapse; and for group 3, from 49 to 77 months. Upon comparing the mean height and mean weight of group 1 with that of group 3 we find that the group with early menarcheal ages averages 2.2 inches taller and 13.7 pounds heavier than that with late menarcheal ages. The obtained differences in the means are, respectively, 2.4 and 3.4 times their standard errors. Next, comparing group 2 with group 3 for this same chronological age, we find the mean height of the earlier maturing group to be 1.3 inches greater than that of the late maturing group and the mean weight to

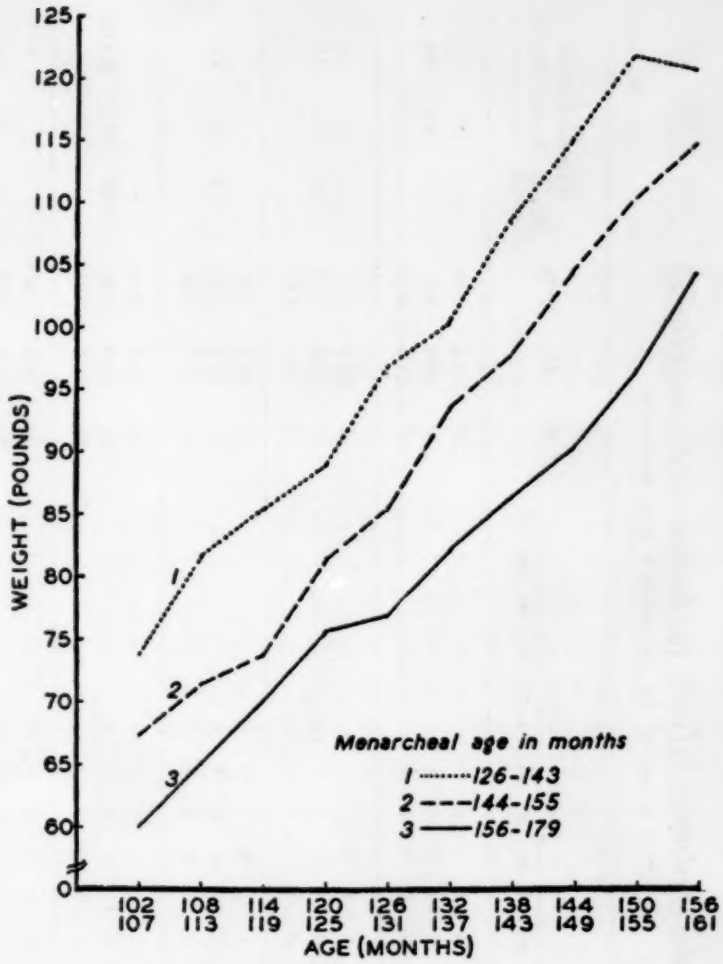


FIG. 4. GROWTH IN WEIGHT OF EARLY, MEDIUM, AND LATE PUBESCENT GIRLS.

be 7.3 pounds heavier. These differences are, respectively, 2.1 and 3.4 times their standard errors. The second of these comparisons (group 2 with group 3) is based upon data that are very satisfactory for the study of the early and late maturing girls at a time well in advance of the menarche. In this case all of the girls are 8½ years old; at least three years will elapse before the menarche is reached by any of them and in some cases 6½ years will elapse before the menarche. But even

## TABLE 14

*Heights of relatively (1) early, (2) medium, and (3) late maturing girls grouped by six-month age intervals*

| CHRONOLOGICAL AGE | PUB. GROUP | HEIGHT (*inches*) 48 | 50 | 52 | 54 | 56 | 58 | 60 | 62 | 64 | 66 | 68 | 70 | *N* | *M* | S. D. | CRITICAL RATIOS $M_1$-$M_2$ | $M_2$-$M_3$ | $M_1$-$M_3$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 102— | 1 | 2 | 3 | 3 | 3 | 4 | .. | .. | .. | .. | .. | .. | .. | 15 | 53.5 | 2.78 | | | |
| 107 | 2 | 2 | 10 | 19 | 7 | .. | .. | .. | .. | .. | .. | .. | .. | 38 | 52.6 | 2.56 | 1.1 | 2.1 | 2.4 |
| | 3 | 6 | 6 | 4 | 1 | 1 | .. | .. | .. | .. | .. | .. | .. | 18 | 51.3 | 2.48 | | | |
| 108— | 1 | 2 | 1 | 8 | 2 | 7 | 1 | .. | .. | .. | .. | .. | .. | 21 | 54.3 | 2.70 | | | |
| 113 | 2 | 1 | 9 | 18 | 16 | 4 | 1 | .. | .. | .. | .. | .. | .. | 49 | 53.7 | 1.98 | 1.0 | 2.1 | 2.3 |
| | 3 | 1 | 5 | 5 | 1 | 1 | .. | .. | .. | .. | .. | .. | .. | 13 | 52.4 | 1.98 | | | |
| 114— | 1 | 1 | 1 | 4 | 6 | 4 | 8 | .. | .. | .. | .. | .. | .. | 24 | 55.9 | 2.82 | | | |
| 119 | 2 | 1 | 3 | 20 | 22 | 16 | 1 | .. | .. | .. | .. | .. | .. | 63 | 54.7 | 1.90 | 1.9 | 2.0 | 3.0 |
| | 3 | .. | 5 | 10 | 9 | 2 | 1 | .. | .. | .. | .. | .. | .. | 27 | 53.8 | 1.96 | | | |
| 120— | 1 | .. | 3 | .. | 5 | 6 | 5 | 6 | .. | .. | .. | .. | .. | 25 | 57.2 | 3.12 | | | |
| 125 | 2 | .. | 1 | 15 | 20 | 21 | 12 | 2 | .. | .. | .. | .. | .. | 71 | 56.0 | 2.24 | 1.8 | 2.5 | 3.3 |
| | 3 | .. | 2 | 10 | 9 | 7 | 2 | .. | .. | .. | .. | .. | .. | 30 | 54.8 | 2.08 | | | |
| 126— | 1 | .. | 1 | 2 | 3 | 8 | 6 | 8 | 2 | .. | .. | .. | .. | 30 | 58.2 | 2.94 | | | |
| 131 | 2 | .. | 1 | 3 | 16 | 27 | 25 | 9 | .. | 1 | .. | .. | .. | 82 | 57.5 | 2.36 | 1.2 | 2.8 | 3.5 |
| | 3 | .. | 1 | 5 | 12 | 14 | 4 | 1 | .. | .. | .. | .. | .. | 37 | 56.0 | 2.02 | | | |

TABLE 14 (*continued*)

| CHRONOLOGICAL AGE | PUB. GROUP | HEIGHT (*inches*) 48 | 50 | 52 | 54 | 56 | 58 | 60 | 62 | 64 | 66 | 68 | 70 | *N* | *M* | S. D. | CRITICAL RATIOS $M_1$-$M_2$ | $M_2$-$M_3$ | $M_1$-$M_3$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 132— | 1 | .. | .. | 2 | 2 | 2 | 7 | 11 | 5 | 3 | .. | .. | .. | 32 | 60.1 | 3.10 | | | |
| 137 | 2 | .. | .. | 2 | 8 | 17 | 27 | 21 | 6 | .. | .. | .. | .. | 81 | 58.9 | 2.32 | 1.9 | 3.7 | 4.4 |
| | 3 | .. | .. | 4 | 12 | 9 | 10 | 5 | 1 | .. | .. | .. | .. | 41 | 57.1 | 2.58 | | | |
| 138— | 1 | .. | .. | .. | 1 | 2 | 2 | 13 | 11 | 3 | .. | .. | .. | 32 | 61.5 | 2.24 | | | |
| 143 | 2 | .. | .. | .. | 4 | 11 | 21 | 31 | 13 | 4 | .. | .. | .. | 84 | 60.2 | 2.31 | 2.7 | 4.2 | 5.9 |
| | 3 | .. | .. | .. | 11 | 13 | 12 | 9 | 3 | 1 | .. | .. | .. | 49 | 58.3 | 2.60 | | | |
| 144— | 1 | .. | .. | .. | 1 | 2 | 1 | 9 | 16 | 4 | 4 | .. | .. | 37 | 62.5 | 2.60 | | | |
| 149 | 2 | .. | .. | .. | .. | 5 | 19 | 24 | 26 | 21 | 2 | .. | .. | 97 | 61.9 | 2.50 | 1.2 | 4.4 | 4.6 |
| | 3 | .. | .. | .. | 4 | 7 | 17 | 14 | 6 | 3 | 1 | .. | .. | 52 | 59.9 | 2.68 | | | |
| 150— | 1 | .. | .. | .. | .. | 2 | 2 | 5 | 22 | 10 | 2 | 1 | .. | 44 | 63.1 | 2.36 | | | |
| 155 | 2 | .. | .. | .. | .. | 1 | 8 | 46 | 40 | 37 | 11 | .. | .. | 143 | 62.9 | 2.14 | 0.5 | 4.05 | 3.5 |
| | 3 | .. | .. | .. | 1 | 4 | 9 | 18 | 18 | 4 | .. | 1 | .. | 55 | 61.4 | 2.46 | | | |
| 156— | 1 | .. | .. | .. | .. | 2 | 5 | 3 | 14 | 14 | .. | 2 | .. | 40 | 63.0 | 2.74 | | | |
| 161 | 2 | .. | .. | .. | .. | 1 | 2 | 39 | 44 | 28 | 14 | 2 | .. | 130 | 63.2 | 2.23 | —0.4 | 2.9 | 1.5 |
| | 3 | .. | .. | .. | 1 | .. | 12 | 22 | 20 | 12 | 3 | 1 | .. | 71 | 62.2 | 2.48 | | | |

## TABLE 15

*Weights of relatively (1) early, (2) medium, and (3) late maturing girls, grouped by six-month age intervals*

| CHRONOLOGICAL AGE | PUB. GROUP | WEIGHT (*pounds*) 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 | *N* | *M* | S. D. | CRITICAL RATIOS $M_1$-$M_2$ | $M_2$-$M_3$ | $M_1$-$M_3$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 102— | 1 | 3 | 3 | 4 | 5 | 1 | .. | .. | .. | .. | .. | .. | .. | .. | 16 | 73.7 | 12.25 | | | |
| 107 | 2 | 11 | 14 | 9 | 4 | 1 | .. | .. | .. | .. | .. | .. | .. | .. | 39 | 67.3 | 10.49 | 1.8 | 3.4 | 3.4 |
| | 3 | 10 | 7 | 1 | .. | .. | .. | .. | .. | .. | .. | .. | .. | .. | 18 | 60.0 | 6.00 | | | |
| 108— | 1 | 1 | 4 | 2 | 7 | 2 | 1 | 1 | .. | .. | .. | .. | .. | .. | 18 | 81.7 | 14.83 | | | |
| 113 | 2 | 7 | 13 | 17 | 8 | 1 | .. | .. | .. | .. | .. | .. | .. | .. | 46 | 71.3 | 10.08 | 2.7 | 2.4 | 4.1 |
| | 3 | 6 | 10 | .. | 3 | .. | .. | .. | .. | .. | .. | .. | .. | .. | 19 | 65.0 | 9.73 | | | |
| 114— | 1 | 2 | 3 | 4 | 5 | 5 | 3 | 2 | .. | .. | .. | .. | .. | .. | 24 | 85.4 | 17.00 | | | |
| 119 | 2 | 3 | 26 | 15 | 11 | 5 | 1 | .. | .. | .. | .. | .. | .. | .. | 61 | 73.7 | 11.18 | 3.2 | 1.3 | 3.7 |
| | 3 | 6 | 15 | 6 | 1 | 2 | 2 | .. | .. | .. | .. | .. | .. | .. | 32 | 70.0 | 13.45 | | | |
| 120— | 1 | 1 | 2 | 7 | 5 | 3 | 4 | 3 | 1 | .. | .. | .. | .. | .. | 26 | 88.8 | 17.86 | | | |
| 125 | 2 | 2 | 13 | 19 | 19 | 10 | 4 | 1 | .. | .. | .. | .. | .. | .. | 66 | 81.4 | 12.00 | 1.9 | 2.1 | 3.2 |
| | 3 | 2 | 14 | 12 | 3 | 3 | 1 | 2 | .. | .. | .. | .. | .. | .. | 37 | 75.5 | 14.57 | | | |
| 126— | 1 | .. | 2 | 6 | 5 | 5 | 5 | 4 | 2 | 1 | 1 | .. | .. | .. | 31 | 96.6 | 20.20 | | | |
| 131 | 2 | .. | 13 | 17 | 18 | 16 | 10 | 3 | .. | .. | .. | .. | .. | .. | 77 | 85.3 | 13.96 | 2.9 | 3.0 | 4.7 |
| | 3 | 3 | 12 | 14 | 6 | 4 | .. | 3 | .. | .. | .. | .. | .. | .. | 42 | 76.9 | 14.85 | | | |

TABLE 15 (*continued*)

| CHRONOLOGICAL AGE | PUB. GROUP | WEIGHT (*pounds*) 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 | *N* | *M* | S.D. | CRITICAL RATIOS $M_1$-$M_2$ | $M_2$-$M_3$ | $M_1$-$M_3$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 132— | 1 | .. | 2 | 3 | 6 | 3 | 7 | 5 | 2 | .. | 1 | 1 | .. | .. | 30 | 100.3 | 21.16 | | | |
| 137 | 2 | .. | 3 | 13 | 21 | 18 | 11 | 5 | 5 | 2 | .. | .. | .. | .. | 78 | 93.5 | 16.18 | 1.6 | 4.0 | 4.1 |
| | 3 | 1 | 9 | 17 | 15 | 6 | 1 | 2 | 1 | 1 | .. | .. | .. | .. | 53 | 82.2 | 15.41 | | | |
| 138— | 1 | .. | .. | 1 | 2 | 7 | 9 | 6 | 4 | 2 | .. | .. | 1 | .. | 32 | 108.7 | 17.46 | | | |
| 143 | 2 | .. | 1 | 8 | 16 | 25 | 12 | 6 | 7 | 3 | .. | .. | .. | .. | 78 | 97.8 | 16.00 | 3.0 | 4.1 | 5.9 |
| | 3 | .. | 6 | 17 | 13 | 11 | 4 | 1 | 2 | .. | 1 | .. | .. | .. | 55 | 86.3 | 16.13 | | | |
| 144— | 1 | .. | .. | .. | 1 | 5 | 7 | 14 | 5 | 3 | 2 | .. | 1 | .. | 35 | 115.0 | 15.68 | | | |
| 149 | 2 | .. | 1 | 1 | 18 | 21 | 22 | 14 | 10 | 3 | 3 | 1 | .. | .. | 94 | 104.6 | 16.94 | 3.2 | 5.3 | 7.5 |
| | 3 | .. | 5 | 12 | 22 | 15 | 7 | 3 | 2 | 1 | .. | 1 | .. | .. | 68 | 90.3 | 16.65 | | | |
| 150— | 1 | .. | .. | .. | 1 | 3 | 8 | 8 | 8 | 7 | 6 | 1 | .. | 1 | 43 | 121.7 | 18.16 | | | |
| 155 | 2 | .. | .. | 1 | 9 | 17 | 31 | 26 | 7 | 10 | 3 | 1 | 1 | .. | 106 | 110.2 | 16.40 | 3.6 | 4.8 | 7.0 |
| | 3 | .. | .. | 10 | 21 | 14 | 10 | 3 | 4 | 2 | .. | .. | 2 | .. | 66 | 96.4 | 19.30 | | | |
| 156— | 1 | .. | .. | .. | .. | 4 | 8 | 6 | 10 | 6 | 4 | 1 | .. | .. | 39 | 120.6 | 16.00 | | | |
| 161 | 2 | .. | .. | .. | 3 | 22 | 20 | 26 | 7 | 5 | 9 | 2 | 2 | 1 | 97 | 114.5 | 19.23 | 1.9 | 3.6 | 4.9 |
| | 3 | .. | .. | 2 | 14 | 23 | 23 | 12 | 4 | 2 | 1 | 2 | 1 | 1 | 85 | 104.5 | 18.68 | | | |

at this early age there is a differential with respect to height and weight between girls who will mature relatively early and those who will mature relatively late.

Let us next consider the height and weight data for the group with chronological ages ranging from 108 to 113 months. In this case, also, the minimal clearances between chronological ages and the menarcheal ages are such that only to a slight degree is one concerned with the pubescent spurt (4) in physical development. The mean heights and weights of group 1 exceed the corresponding means of group 3 by 1.9 inches and 16.7 pounds, respectively. The critical ratios for these differences are, respectively, 2.3 and 4.1. For group 2 the mean height and weight exceed the corresponding means of group 3 by 1.3 inches and 6.3 pounds. Critical ratios for these differences are 2.1 and 2.4. As can be seen, the trends of results for this age category are the same as those of the preceding one.

Further study of Tables 14 and 15 indicates that similar relations between early and late maturing girls hold at all ages prior to the

TABLE 16

*Improvement in the prediction of physical size from chronological age when pubescence status is taken into account over that to be obtained from chronological age alone*

| MEASUREMENT | STANDARD ERROR OF ESTIMATE FROM AGE | | | IMPROVEMENT | |
|---|---|---|---|---|---|
| | Pub. & Non-pub. not separated | Pubescent | Non-pub. | Pub. | Non-pub. |
| Height ..... | 2.70 | 2.36 | 2.74 | 12% | —1.5% |
| Weight ..... | 18.10 | 16.90 | 15.77 | 7% | 13 % |
| Bi-iliac ..... | 1.67 | 1.52 | 1.57 | 9% | 6 % |
| Chest width ... | 1.59 | 1.46 | 1.59 | 8% | 0 |

menarche for which we have data. It would seem to be established, therefore, that, so far as height and weight are concerned, differences in the physiques of girls of differing menarcheal ages did not appear for the first time at or only a few months before the menarche, but that they were, in fact, nearly as pronounced three years preceding

the menarche as they were at any later time.[1] It is highly desirable that data be procurred whereby these relationships may be examined in the same subjects from infancy to adult life.

### 4. PREDICTION

The differences found between the physiques of pubescent and non-pubescent girls, and also those between girls pubescent a relatively short time and those pubescent a longer time suggest that prediction of average size throughout these ages could be improved by taking into consideration the pubertal status of individuals. Our data are not satisfactory for establishing norms for various groups. Nevertheless, they have been examined by us from this point of view in order to obtain a general idea of the magnitude of the improvement in prediction that may be expected.

In Table 16 are given the standard errors of estimated size, computed from the regressions upon chronological age. They were determined from the following kinds of data: (1) measurements of pubescent and non-pubescent girls distributed together; (2) measurements of pubescent girls distributed separately; (3) measurements of non-pubescent girls distributed separately.

These statistics indicate that improvements in prediction ranging from zero to 13 per cent might be obtained by dealing separately with pubescent and non-pubescent girls. These improvements should be considered as average because, as indicated above, the regression lines from which the predictions were made are not parallel for the two groups but are more separated at the younger ages than at the older. Thus, the improvements should be greater at the younger ages and lesser at the older ages, the difference depending upon the differences in the slopes of the regression lines.

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[1]The regressions of height and weight on menarcheal age in the pre-menstrual years gives one another view of these same relations. These regression coefficients are as follows:

| *Age in months* | *Height on Menarcheal Age* | $\sigma$ | *Weight on Menarcheal Age* | $\sigma$ |
|---|---|---|---|---|
| 102-107 | —.061 | .026 | —.460 | .138 |
| 108-113 | —.065 | .025 | —.496 | .135 |
| 114-119 | —.083 | .021 | —.516 | .124 |
| 120-125 | —.085 | .021 | —.507 | .127 |

If more detailed aspects of the pubescence status were taken into account such as length of time pubescent, menarcheal age, and estimated length of time prior to pubescence as indicated by secondary sexual development (4), a still greater improvement in prediction should be obtained. The amount may even be sufficient to warrant taking into account the individual's status of progress toward sexual maturity in normative studies of physical development during the early adolescent period.

## SUMMARY

This study of the relations between menarcheal status and height, weight, chest width and bi-iliac diameter may be summarized as follows:

1. *Height.* Data are presented for girls of the ages 8.5 to 16 years. (a) Groups of postmenarcheal girls are, on the average, taller than premenarcheal girls at all ages between 10.5 and 15 years. At the age of 16 years the premenarcheal group becomes the taller. (b) The positive slope of the regression of height upon chronological age is greater in a group of premenarcheal girls than in a group of postmenarcheal girls (.042±.003 and .133±.006). (c) The mean heights of groups of girls who are beyond the menarche more than one year is slightly but not reliably greater than those of similar ages who have been pubescent one year or less. (d) The slope of the regression of height upon chronological age in the case of girls who are postmenarcheal by one year or less is significantly positive (.051±.088). In the case of girls more than one year beyond the menarche the slope of this regression does not differ significantly from zero (.015±.008). (e) Data extending back to the age of 8.5 years indicate that at this age, and at all of the other premenarcheal ages for which data are at hand, girls who will mature relatively early are taller than those who will mature relatively late.

2. *Weight* Data are presented for girls between the ages of 8.5 and 16 years. (a) Groups of postmenarcheal girls are, on the average, heavier than premenarcheal girls at all ages between 10.5 and 16 years. (b) The positive slope of the regression of weight upon chronological age is greater for premenarcheal than for postmenarcheal girls (.127 ±.034 and .388±.038). (c) Girls who are beyond the menarche by

more than one year are heavier at all ages than those who are postmenarcheal by one year or less. (d) The slopes of the regressions of weight upon chronological age do not differ significantly from zero either in the case of girls who are postmenarcheal by one year or less (—.065±.054) or in the case of girls who are postmenarcheal more than one year (—.036±.054). (e) Girls who become pubescent relatively early are heavier than those who become pubescent relatively late at all of the pre-pubertal ages beyond 8.5 years (backward limit of our data).

3. *Chest Width* Data are presented for girls of the ages 10.5 to 16 years. (a) The means for groups of postmenarcheal girls are, on the average, greater than those for groups of premenarcheal girls. (b) The positive slope of the regression of chest-width upon chronological age is greater in the case of premenarcheal girls than in the case of postmenarcheal girls (.016±.003 and .045±.004). (c) Girls who have been pubescent more than one year are broader, on the average, than girls who have been pubescent one year or less. (d) The slopes of the regressions of chest width upon chronological age do not differ reliably from zero either for girls who are postmenarcheal by one year or less (—.003±.004) or for those who are postmenarcheal by more than one year (.010±.004).

4. *Bi-iliac Diameter* Data are presented for girls of the ages 10.5 to 16 years. (a) Groups of postmenarcheal girls are, on the average, broader than groups of premenarcheal girls. (b) The positive slope of the regression of bi-iliac diameter on chronological age is greater for premenarcheal than for postmenarcheal girls (.029±.004 and .052 ±.004). (c) Girls who have been pubescent more than one year are broader than those who have been pubescent one year or less. (d) The slope of the regression of bi-iliac diameter upon chronological age is positive for girls who are postmenarcheal one year or less (.022±.006). In the case of girls who are postmenarcheal more than one year, the regression does not differ significantly from zero (.013±.005).

5. The standard errors of the mean measures of physique herein studied, as estimated from chronological age are improved by amounts up to 13 per cent when the pubescence status of the individual is taken into account.

## REFERENCES

1. BARKER, R. G., and C. P. STONE: Physical development in relation to menarcheal age in university women. HUMAN BIOLOGY, 1936, 8, 197-222.
2. BOAS, F.: Studies in growth. HUMAN BIOLOGY, 1932, 4, 307-350.
3. FLORY, C. D.: Predicting puberty. *Child Development*, 1935, 6, 1-6.
4. PRYOR, H. B.: Certain physical and physiological aspects of adolescent development in girls. *J. Pediatrics*, 1936, 8, 52-62.

# DIFFERENCES IN THE UTILIZATION OF CALCIUM AND PHOSPHORUS IN NEGATIVE AND POSITIVE BALANCES DURING PREGNANCY

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IT IS as difficult a task to interpret the significance of a negative or a positive balance as it is to relegate individual differences to their proper place in determining human metabolic needs. At first sight, a negative balance is usually considered to result either from a low level of ingestion, or from food composition faulty enough to interfere with proper digestion and assimilation. Assimilation may be affected by alimentary rate, which in turn is thought to be influenced by the composition of the substances ingested. All of these facts have been recognized by investigators interested in getting at the reasons why one finds individual differences in metabolism, but not enough work has yet been done to show wherein negative and positive balances differ, although the two types have been obtained during pregnancy by all investigators.

While data on the use of three-day balance periods (5) in studying human metabolism during pregnancy were being analyzed at Fels Fund, the problem of estimating metabolic tendencies and aspects of fetal development from them arose because some subjects persisted in negative balance throughout the greater part of the gestation period. The first inclination was to discount such a finding at once, since ordinarily a negative balance is thought to indicate either faulty or insufficient ingestion. Gross inspection of the physical status of the subjects, their weight gains and the condition of their infants at birth, together with the facts obtained about the quantity and theoretical composition of the

*The authors wish to express their appreciation to Martha Potgieter and Virginia Torbet for their assistance in collecting materials for the balances, and to Dr. L. W. Sontag, Director, for his interest in the work.

food ingested day by day, did not seem to warrant such an unqualified discount. Consequently, we assembled all of our data on balances which had been determined by use of a three-day balance period, and combined them with the data published by Macy (4) and Coons (2) (3) and their co-workers. Forty-four balances on seven Fels Fund subjects, forty-three from the two studies presented by Coons and her co-workers, and the twelve given by Macy and her co-workers are considered here. Negative and positive balances obtained at the same stage in pregnancy were then selected from these to see how they compared with respect to the following points:

a. Levels of ingestion
b. Amounts excreted in the urine and feces
c. Urinary and fecal excretion per gram of ingestion, i.e., urinary partition and fecal partition
d. The urinary-fecal ratio
e. Relation between the alimentary rate and the balance
f. Relation between the balance and the period in pregnancy

Only eighteen matchings could be made for comparing negative and positive balances as such when two criteria were used, namely, that the individual be in a state of negative balance both in calcium and in phosphorus, and that negative and positive balance matchings fall chronologically within a week of each other. The twenty-three Fels balances selected for the negative-positive comparison are starred in Table 1, and those taken from the work of Macy and Coons are described in full in their own papers.*

## METHODS OF COMPARISON

1. Our first interest was to see whether a negative and positive balance differed before we combined them to interpret average tendencies in assimilation. Hence the eighteen negative balances were com-

*Balances selected from the study made by Macy and her co-workers ('30) were: subject VI at 20, 14, 10, 6 and 2 weeks; subject VII at 26, 10 and 6 weeks; subject VIII at 10 and 6 weeks. The balances selected from those computed by Coons and her co-workers in her first study (designated in this study as Coons I ('30) were: subject A at 28, 22, 20, 12 and 7 weeks; subject B at 24, 18, 11, 5 and 1 weeks; subject C at 13 and 11 weeks; subject D at 10 and 2 weeks; subject E at 8 weeks; subject F at 25 and 8 weeks; subject G at 11 weeks. Those selected from a second study made by Coons and her co-workers (designated in this study as Coons II ('34) were: subject IV at 22 weeks; subject VI at 22, 17 and 2 weeks. The time was expressed in weeks pre-delivery in each case.

## TABLE 1

*Calcium and phosphorus balances determined by the three-day period method*

| SUBJECT | WEEKS PRE-DELIVERY | CALCIUM (*grams per day*) | | | PHOSPHORUS (*grams per day*) | | | ALIMENTARY RATE (*hours*) |
|---|---|---|---|---|---|---|---|---|
| | | Food | Feces | Urine | Food | Feces | Urine | |
| II | 31 | 1.072 | 2.302 | 0.256 | 1.116 | 1.523 | 0.732 | ... |
| | 27* | 1.058 | 2.146 | 0.288 | 1.101 | 1.570 | 1.435 | ... |
| | 11* | 1.104 | 1.397 | 0.356 | 1.150 | 0.815 | 1.052 | ... |
| $III_A$ | 23* | 1.060 | 1.211 | 0.229 | 1.225 | 0.761 | 1.035 | ...** |
| | 20 | 1.898 | 1.697 | 0.177 | 0.744 | 0.924 | 0.971 | ...** |
| | 16 | 1.822 | 1.752 | 0.137 | 1.957 | 1.123 | 1.005 | ...** |
| | 11* | 1.137 | 1.388 | 0.284 | 1.390 | 0.786 | 0.748 | ...** |
| | 7* | 1.546 | 1.154 | 0.248 | 1.413 | 0.645 | 0.812 | ...** |
| | 3 | 1.958 | 1.104 | 0.170 | 1.294 | 1.374 | 0.760 | ...** |
| $III_B$ | 32 | 0.851 | 0.702 | 0.120 | 0.701 | 0.909 | 0.475 | 50.7 |
| | 28 | 2.169 | 1.896 | 0.268 | 2.036 | 1.307 | 0.890 | 47.6** |
| | 24* | 1.934 | 2.042 | 0.191 | 1.873 | 1.387 | 0.720 | 50.0** |
| | 20* | 1.308 | 1.080 | 0.169 | 1.430 | 1.470 | 0.227 | 39.0** |
| | 17 | 2.389 | 1.562 | 0.137 | 1.683 | 0.974 | 0.754 | 49.3 |
| | 12* | 1.333 | 1.401 | 0.168 | 1.387 | 0.924 | 0.407 | 49.9 |
| | 7* | 1.475 | 0.578 | 0.144 | 0.585 | 0.442 | 0.655 | 48.1 |
| | 1 | 1.455 | 0.979 | 0.130 | 1.527 | 0.778 | 0.774 | 49.1 |
| IV | 31 | 1.400 | 1.654 | 0.185 | 1.461 | 0.807 | 0.848 | ... |
| | 27 | 1.183 | 0.866 | 0.241 | 1.410 | 0.615 | 0.863 | ... |
| | 23 | 1.266 | 1.318 | 0.214 | 1.887 | 0.896 | 0.915 | ... |
| | 19 | 1.721 | 1.168 | 0.260 | 1.867 | 0.659 | 0.909 | ... |
| | 7 | 1.351 | 0.832 | 0.213 | 1.797 | 0.500 | 0.765 | ... |
| | 1 | 2.078 | 1.594 | 0.138 | 1.489 | 0.799 | 1.232 | ... |
| VI | 23* | 0.911 | 1.511 | 0.175 | 0.885 | 0.880 | 0.634 | 49.9*** |
| | 19 | 1.756 | 1.303 | 0.183 | 1.123 | 0.566 | 0.843 | 48.7*** |
| | 14* | 1.255 | 0.898 | 0.210 | 1.036 | 0.623 | 0.384 | 54.2*** |
| | 11 | 1.591 | 1.056 | 0.152 | 1.899 | 0.462 | 0.910 | 39.4*** |
| | 7 | 1.725 | 1.403 | 0.251 | 1.407 | 0.776 | 0.871 | 72.1*** |
| | 3* | 1.578 | 1.558 | 0.141 | 1.390 | 0.898 | 0.686 | 49.1*** |
| VII | 11* | 1.853 | 1.229 | 0.204 | 1.397 | 0.777 | 0.707 | 50.4 |
| | 7* | 1.856 | 0.914 | 0.235 | 1.939 | 0.589 | 0.858 | 49.6 |
| | 1* | 1.656 | 0.644 | 0.484 | 1.543 | 0.375 | 0.708 | 62.6 |

TABLE 1 (*continued*)

| SUBJECT | WEEKS PRE-DELIVERY | CALCIUM (*grams per day*) | | | PHOSPHORUS (*grams per day*) | | | ALIMENTARY RATE (*hours*) |
|---|---|---|---|---|---|---|---|---|
| | | Food | Feces | Urine | Food | Feces | Urine | |
| VIII | 12* | 2.076 | 1.400 | 0.366 | 1.590 | 0.808 | 0.848 | 43.6 |
| | 8* | 1.009 | 1.002 | 0.357 | 1.527 | 0.863 | 0.656 | 49.5 |
| | 4 | 1.675 | 0.834 | 0.274 | 1.414 | 0.574 | 0.356 | 48.0 |
| | 1 | 1.875 | 0.970 | 0.214 | 1.094 | 0.701 | 0.702 | 51.9 |
| X | 34 | 2.020 | 1.528 | 0.244 | 1.866 | 1.260 | 0.924 | ... |
| | 30 | 2.268 | 2.108 | 0.278 | 1.795 | 1.509 | 0.894 | ... |
| | 26* | 1.505 | 0.968 | 0.298 | 1.747 | 0.592 | 1.070 | ... |
| | 22* | 1.089 | 1.163 | 0.236 | 1.142 | 0.702 | 0.713 | ... |
| | 18* | 1.142 | 1.205 | 0.195 | 1.299 | 0.678 | 0.712 | ... |
| | 14* | 1.799 | 1.017 | 0.124 | 2.075 | 0.693 | 0.833 | ... |
| | 10* | 1.255 | 2.325 | 0.201 | 1.253 | 1.079 | 0.780 | ... |
| | 6* | 1.271 | 1.595 | 0.260 | 1.170 | 0.946 | 0.741 | ... |

* Fels balances used in the matched comparisons.
** Subject used milk of magnesia.
*** Subject used mineral oil.

pared with the eighteen positive balances in the following ways: (a) Means and standard deviations were computed for calcium and phosphorus in food, feces, urine, fecal and urinary partition,* and for urinary and fecal ratios for negative and positive balances alike. (b) Critical ratios were computed by the standard mathematical method for it from the data indicated in (a). From such ratios inferences could be drawn as to the significance of the differences found on the basis of the theory of probability of occurrence, indicated by such ratios, given in the table in the Handbook of Chemistry and Physics, eighteenth edition, page 180. A difference was called *significant* in this paper if the critical ratio was 3.0 or greater.

2. Having made these calculations, the relations between balance, level of ingestion and stage in pregnancy (expressed in weeks predelivery) for the total ninety-nine balances were studied by the use of a Pearson product-moment correlation. The matched balances were then considered by this method of comparing to Table 2.

*A partition is calculated here by dividing excretion by ingestion. The urinary-fecal ratio is calculated by dividing the kidney output by the intestinal output.

3. Finally, correlations were computed between the following items, for Fels subjects III, VI, VII and VIII on whom twenty-four hour samplings of alimentary rates were available: (Table 1)

a. Balance and alimentary rate
b. Moisture in food and alimentary rate
c. Alimentary rate and moisture in feces
d. Alimentary rate and moisture in feces and urine
e. Alimentary rate and stage in pregnancy (expressed in weeks pre-delivery)

## COMPARISON

1. The following points about the significance of difference in calcium and phosphorus ingested, and differences in the amounts excreted by the kidney and the intestine in negative and positive balance, respectively, were obtained.

### *Calcium*

a. *Level of ingestion.* Differences in the average amount of calcium ingested when the subjects were either in negative or positive balance, respectively, were not great enough to be called significant. (Negative balance M* = 1.367 ± .059 grams per day, SD* = .371 ± .042; positive balance M = 1.465 ± .090 grams per day, SD = .564 ± .063. The critical ratio for M = .91, for SD = 2.55).

b. *Urinary and fecal excretion.* Subjects in positive balance excreted more calcium per day by way of the kidney than those in negative balance. The difference was not significant. (Positive balance M = .324 ± .026 grams per day, SD = .164 ± .018; negative balance M = .281 ± .024 grams per day, SD = .149 ± .017. The critical ratio for M = 1.22, for SD = .61).

Significantly more calcium was excreted by way of the intestine when a subject was in negative balance. (Negative balance M = 1.601 ± .075 grams per day, SD = .474 ± .053; positive balance M = 1.013 ± .078 grams per day, SD = .492 ± .055. The critical ratio for M = 5.44, for SD = .24).

*M designates mean and its probable error and SD designates standard deviation and its probable error.

c. *Urinary and fecal partition.* When the excretion by way of the kidney was considered in terms of ingestion, the difference between subjects in negative and positive balance was found to be insignificant. (Positive balance M = .227 ± .013, SD = .084 ± .009; negative balance M = .211 ± .016, SD = .098 ± .011. Critical ratio for M = .78, for SD = .98).

Subjects in positive balance excrete significantly less calcium by way of the intestine per gram of calcium ingested than those in negative balance. (Positive balance M = .227 ± .013, SD = .084 ± .009; Negative balance M = 1.193 ± .048 grams per day, SD = .301 ± .034. The critical ratio for M = 9.8, for SD = 4.3).

d. *Urinary-fecal ratio.* In accord with the results in (c) the urinary-fecal ratio is greater for subjects in positive balance. The difference is significant, but loses some force since the critical ratio for the standard deviation is so great. (Negative urinary-fecal ratio M = .184 ± .015, SD = .094 ± .011; positive urinary-fecal ratio M = .384 ± .041, SD = .255 ± .029. The critical ratio for M = 4.58, for SD = 5.19).

### *Phosphorus*

a. *Level of ingestion.* These subjects in negative balance ingested less phosphorus than those in positive balance. The difference approaches significance. (Negative balance M = 1.332 ± .059 grams per day, SD = .374 ±. 042; positive balance M = 1.535 ± .063 grams per day, SD = .397 ± .045. The critical ratio for M = 2.35, for SD = .37).

b. *Urinary and fecal excretion.* Less phosphorus was excreted by way of the kidney when the subjects were in positive balance. The difference was not significant, but was greater than that found for calcium. (Negative balance M = .759 ± .038 grams per day, SD = .240 ± .027; positive balance M = .696 ± .026 grams per day, SD = .165 ± .019. The critical ratio for M = 1.37, for SD = 2.27).

When subjects were in negative balance, significantly more phosphorus was excreted by the intestinal route. This is in accord with the calcium findings. (Negative balance M = .838 ± .043 grams per day, SD = .272 ± .031; positive balance M = .589 ± .036 grams per day, SD = .226 ± .025. The critical ratio for M = 4.44, for SD = 1.15).

c. *Urinary and fecal partition.* The urinary partition for the negative group tends to be greater than the partition in the positive group. The difference is not decisive since the difference in individual partitions is so great. (Negative balance M = .544 ± .029 grams per day, SD = .180 ± .020; positive balance M = .460 ± .019 grams per day, SD = .118 ± .013. The critical ratio for M = 2.4, for SD = 2.6).

The fecal partition showed as decided a difference in quantity of phosphorus excreted as was shown for calcium. (Negative balance partition M = .645 ± .022, SD = .137 ± .015; positive balance partition M = .388 ± .021, SD = .134 ± .015. The critical ratio for M = 8.4, for SD = .14).

d. *Urinary-fecal ratio.* The urinary-fecal ratio confirms the findings in (b) and (c) and are similar to the findings for calcium. (Positive urinary-fecal ratio M = 1.360 ± .055; SD = .344 ± .039; negative urinary-fecal ratio M = .997 ± .055, SD = .343 ± .039. The critical ratio for M = 4.66, for SD = .02).

It is apparent that on the average there was one difference in the alimentary balance between subjects in the negative and positive state—the amount excreted in the feces. At once one might ask whether this difference might not be due to the fact that the Fels balances were determined by short period sampling and chance aberrant conditions masked the true physiological state of the individual. Many of our balances were negative. It seemed to us from the findings that the larger amounts excreted in the feces when a subject was in negative balance cannot be attributed alone to possible difficulties encountered in distinguishing a marker properly in short period sampling.

The quantity of calcium or phosphorus excreted in the feces for all groups of subjects studied followed the order of the quantity ingested—the greater the ingestion level the greater the excretion. The average difference in fecal excretion between the groups in positive and negative balance is 58.0 per cent for calcium and 24.3 per cent for phosphorus—greater in negative balance in each case. Therefore, it seems probable that while short period sampling contains pitfalls, since the difference points to as great and as consistent a difference as this that the effect is not due to technique in sampling alone.

As the evidence stands, amount ingested is not the deciding factor for calcium nor wholly for phosphorus unless the small difference which existed is physiologically more decisive than these findings show.

Toverud and Toverud ('31) found that raising the level of ingestion from less than 1 gram to between 1 and 2 grams for either calcium or phosphorus clearly decreased the frequency with which negative balances occurred.

The ingestion level for subjects in negative balance considered here is greater than 1 gram per day. Small and mathematically insignificant increments in ingestion or changes in type may produce a shift from negative to positive balance. However, since the level is within Toverud and Toverud's range for probable change to positive balance, it would seem that the amount ingested loses significance and points either toward the influence of type of ingestion, or difference in assimilation.

At this stage in our investigation, it can only be said that the diets were grossly similar in either case as to one of the chief sources for calcium and phosphorus; namely, milk, except for subject III. During both pregnancies she supplemented her milk ingestion (taken regularly, but in small amounts) with dicalcium phosphate and phosphoric acid until three months before her delivery in 1934. Interestingly enough, she was in positive balance at the beginning of her third pregnancy on a low level of calcium ingestion — .851 grams — without therapy.

These results, then, could indicate physiological difference unless the calcium and phosphorus ingested in the state of negative balance indicated here proves to be more difficult to assimilate than the data indicate theoretically. The significant difference did occur in fecal excretion, but the kidney mechanism selected similar amounts in either case.

All Fels subjects except subject VIII reenforced their diets with cod liver oil or haliver oil regularly throughout pregnancy.

### 2. RELATION BETWEEN BALANCE, INGESTION LEVEL AND STAGE IN PREGNANCY

The matching ruled out so many of the ninety-nine balances available that it was not clear whether ingestion was increased as the fetal demands increased regardless of the type of balance obtained or whether the balance changed as the level of ingestion changed. Therefore, a series of correlations on the ninety-nine balances as a whole were computed to see what they would reveal about these points (Table 2). Although the $r$'s were small, the bulk of the evidence in them seemed to us to indicate a uniform tendency toward specific interrelations, and in some cases quite close interrelation, for biological material.

## TABLE 2

*Correlations on the ninety-nine balances as a whole*

| CORRELATING | STUDY | NO. OF BALANCES | CALCIUM CORRELATIONS | PHOSPHORUS CORRELATIONS |
|---|---|---|---|---|
| Weeks Pre-delivery and Balance | Coons I | 23 | −.65 ± .08 | −.25 ± .14 |
| | Coons II | 20 | −.38 ± .13 | +.44 ± .12 |
| | Macy | 12 | −.24 ± .13 | −.41 ± .16 |
| | Fels | 44 | −.43 ± .08 | −.45 ± .08 |
| | Total values | 99 | −.42 ± .06 | −.35 ± .06 |
| | Negative balance | 18 | +.53 ± .11 | −.68 ± .09 |
| | Positive balance | 18 | −.15 ± .16 | −.14 ± .16 |
| Weeks Pre-delivery and Ingestion | Coons I | 23 | +.42 ± .12 | +.15 ± .14 |
| | Coons II | 20 | +.49 ± .11 | +.57 ± .10 |
| | Macy | 12 | +.39 ± .17 | +.43 ± .16 |
| | Fels | 44 | −.11 ± .10 | −.68 ± .06 |
| | Total values | 99 | +.21 ± .07 | +.08 ± .07 |
| | Negative balance | 18 | −.16 ± .16 | +.04 ± .16 |
| | Positive balance | 18 | +.23 ± .15 | +.18 ± .15 |
| Balance and Ingestion | Coons I | 23 | +.18 ± .14 | +.52 ± .10 |
| | Coons II | 20 | +.20 ± .15 | +.77 ± .06 |
| | Macy | 12 | −.08 ± .19 | +.58 ± .13 |
| | Fels | 44 | +.61 ± .07 | +.53 ± .07 |
| | Total values | 99 | +.23 ± .07 | +.50 ± .05 |
| | Negative balance | 18 | +.17 ± .15 | +.44 ± .13 |
| | Positive balance | 18 | +.18 ± .15 | +.77 ± .07 |
| Weeks Pre-delivery and Balance, Ingestion Held Constant | Coons I | 23 | −.70 ± .07 | −.39 ± .12 |
| | Coons II | 20 | −.56 ± .10 | +.00 ± .15 |
| | Macy | 12 | −.23 ± .18 | −.90 ± .04 |
| | Fels | 44 | −.47 ± .08 | −.14 ± .10 |
| | Total values | 99 | −.49 ± .05 | −.45 ± .05 |
| | Negative balance | 18 | +.57 ± .11 | −.78 ± .10 |
| | Positive balance | 18 | −.20 ± .15 | −.44 ± .13 |
| Balance and Ingestion, Weeks Pre-delivery Held Constant | Coons I | 23 | +.66 ± .08 | +.58 ± .09 |
| | Coons II | 20 | +.48 ± .12 | +.70 ± .08 |
| | Macy | 12 | +.02 ± .20 | +.92 ± .03 |
| | Fels | 44 | +.62 ± .06 | +.34 ± .09 |
| | Total values | 99 | +.36 ± .06 | +.57 ± .05 |
| | Negative balance | 18 | +.31 ± .14 | +.64 ± .09 |
| | Positive balance | 18 | +.22 ± .15 | +.81 ± .10 |

The results show that stage in pregnancy has some effect upon retention regardless of the balance obtained. Calcium and phosphorus retention in general increased as pregnancy progressed except phosphorus in Coons II group. However, the role of ingestion is not clear.

Increase in calcium ingestion did not produce much of an increase in retention in Coons' subjects; the correlation for the Fels group who had a higher level of ingestion than the Coons' groups had, indicates that there was a closer positive relation between calcium ingestion and retention in the Fels group. On the other hand, Macy's group had the highest level of calcium ingestion, and there is no indication from the correlations that calcium ingestion and retention were interdependent. In Coons' and Fels' subjects, retention increased as pregnancy progressed.

Phosphorus ingestion was increased only in the Fels group during the prenatal period. In general, however, retention increased a little as the ingestion level increased. Unlike the results for calcium, the correlation for Macy's group for phosphorus suggested a fairly close relationship between level of ingestion and resultant balance, and stage in pregnancy had quite an effect upon the balance obtained.

When the level of both calcium and phosphorus ingestion was held constant, and all ninety-nine balances—negative and positive, small and large retentions—are considered, retention increased a little for every group except Coons II as pregnancy progressed.

These facts brought our attention back to the original problem of interpreting the differences in assimilation in negative and positive balance. Relations in each of the two groups were now correlated like the entire group, keeping in mind that the sampling was small.

The calcium balance for the negative group decreased somewhat as pregnancy progressed, although the phosphorus balance increased. This was the one outstanding difference between the negative and positive balances. The quantity of calcium ingested correlated indifferently with the negative balance according to these findings whereas phosphorus ingestion tended to increase the size of the phosphorus balance.

In the positive balance group on the other hand there was very little relation between stage in pregnancy, calcium ingestion and the balance. Phosphorus balance and ingestion were somewhat interdependent, but stage in pregnancy did not have much effect upon their relationship.

Finally, some points were noted about the effects of alimentary rate and moisture in the food upon some Fels balances. The third day's sampling of food had been marked off with carbon and carmine markers,

*Notes on the Fels Subjects*

| SUBJECT | AGE | HEIGHT (*ins.*) | WEIGHTS AT BEGINNING AND END OF PREGNANCY (*lbs.*) | BMR AT BEGINNING AND END OF PREGNANCY (*per cent*) | DATE OF DELIVERY | WEIGHT OF INFANT (*lbs.*) | LENGTH OF INFANT (*cms.*) | WEEKS BREAST FED | MATERNAL ILLNESS | REMARKS ON INFANT |
|---|---|---|---|---|---|---|---|---|---|---|
| II | 22 | 61.5 | 102 -134.3 | ..... | 7-13-33 | 7.5 | 49.0 | 5 | "cold" 4 days | first born (girl) |
| $III_A$* | 26 | 64.8 | 134 -165 | —16 to 0 | 6-18-33 | 8.5 | ... | 2 | rectal fissure | cyanotic at birth second born (boy) |
| $III_B$** | 27 | 64.8 | 138 -159 | — 6 to — 6 | 10-26-34 | 7.2 | ... | 2 | intestinal "upset" 5 days, rectal fissure | third born (girl) |
| IV | 27 | 68.5 | 138.3-164 | —13 to — 4 | 10- 6-33 | 9.7 | 53.0 | 20 | mild ivy poisoning 3 weeks | slightly post-mature first born (boy) |
| VI | 24 | 61.8 | 112 -145.3 | + 4 to + 9 | 8-30-34 | 7.0 | 48.0 | 10 | "cold" 1 week | second born (girl) |
| VII | 27 | 64.0 | 106 -131.5 | + 2 to +13 | 8-16-34 | 8.8 | 52.8 | 20 | slight albuminuria | second born (boy) |
| VIII | 33 | 64.3 | 131 -148.3 | — 2 to — 5 | 8-30-34 | 7.8 | 49.0 | 30 | hayfever | second born (girl) |
| X | 33 | 67.5 | 148.5-174.3 | 0 to + 1 | 7-18-35 | 8.3 | 52.1 | 25 | severe "cold" 3 weeks | second born (boy) |

*Pregnancy of 1933.

**Pregnancy of 1934.

and their excretion was used as the basis for calculating alimentary rate. This rate is defined here as the time elapsing between the ingestion of the carbon and the appearance of the carmine in the feces. Moisture is considered as the amount of loss in weight in food and feces on room drying. A sampling of the amount of tap water ingested had been included in the food sample. Some dessicated food and fecal weights have been calculated, and approximately 3 to 5 per cent more moisture is given off in these samples upon desiccation.

The average length of the alimentary period was 50.1 ± 1.00 hours. The rate was somewhat dependent upon the amount of moisture in the food ($r = +.65 \pm .09$). Increasing the length of time when the food substances were retained in the body did not produce much drier feces ($r = +.34 \pm .13$). The alimentary rate changed very slightly as pregnancy progressed ($r = -.23 \pm .14$). Subject III resorted to milk of magnesia as a cathartic for the balances indicated in Table 1, and subject number VII to mineral oil. Under these conditions their average rates neither exceeded the average significantly, nor, for subject III, differed markedly from the rate resulting when no therapy was used. The average of 50.1 hours is shorter that the rate indicated by Burnett ('29) in his series of studies on intestinal rate.

The effect of rate on phosphorus balance is masked ($r = .00 \pm .15$). The calcium balance became more positive as the alimentary rate increased ($r = +.45 \pm .12$). This correlation had added weight because the balance was affected but slightly by the stage in pregnancy at which it was studied ($r$ for Ca and stage in pregnancy $= +.15 \pm .14$. For P and stage in pregnancy $= -.58 \pm .10$).

## SUMMARY

Forty-four calcium and phosphorus balances determined at various stages in pregnancy by the three-day method of sampling (5) were compared with fifty-five balances published by Macy and Coons and their co-workers which had been calculated using four to six day metabolism periods. The ninety-nine balances were first considered as a whole, and then separated into negative and positive balance groups. Negative balances were matched against positive balances according to stage in pregnancy to see whether fundamental differences could be seen when women were in negative or positive balance respectively.

It was evident that women in negative balance excreted significantly more calcium and phosphorus by way of the feces than subjects in positive balance. The level of ingestion chosen by these subjects had some effect upon the quantity of phosphorus retained, but little upon the calcium. In general, calcium and phosphorus were retained in slightly increasing amounts for all groups as pregnancy progressed except for Coons' second group of subjects.

An increase in time during which the food substances were retained in the body aided calcium assimilation, but the effects on phosphorus were masked.

From the data it would seem that the causes of increased fecal excretion by subjects in negative balance warrant further investigation. Little difference in selection by the kidney mechanism was seen. The need for further consideration of form in which calcium and phosphorus are ingested, suggested repeatedly by Macy and Coons, are indicated from Fels data, too. The comparison made here is confined to the question of quantity and mode of excretion.

In conclusion we wish to state that for the sake of brevity detailed reference has been made to some of the work of Macy and Coons only. This type of study has been aided greatly because they presented these raw data in detail. We do not wish to ignore the extent of the field of study of calcium and phosphorus metabolism. We were seeking the minimum sampling period which would be valid as a metabolic tool, and since the three day period seemed to be valid, within specific limits, we ventured to extend the comparison into some of the physiological implications of metabolism, which can be approached more fully as the body of data in this field is increased. Differences in utilization not dependent upon level of ingestion, and not clearly attributable to kind were found. Need for additional methods for studying material-fetal inter-dependence in the human are indicated. Calcium and phosphorus determination for meconium and first urine excreted by the infant together with mineral content in blood from the cord may aid in such interpretation.

## LITERATURE CITED

(1.) Burnett, Francis Lowell. The health of anabolic nutrition. *Amer. J. of Public Health* and *The Nation's Health*, 1929, Vol. 19, p. 1215.

(2.) Coons, Callie Mae, and Katherine Blunt. The retention of nitrogen, calcium, phosphorus and magnesium by pregnant women. *J. Biol. Chem.*, 1930, Vol. 86, p. 1.

(3.) Coons, Callie Mae, R. Rand Coons, and Anna T. Schiefelbusch. The acid-base balance of the minerals retained during human pregnancy. *J. Biol. Chem.*, 1934. Vol. 104, p. 757.

(4.) Macy, Icie G., Helen A. Hunscher, Betty Nims, and Sylvia S. McCosh. Metabolism of women during the reproductive cycle. *J. Biol. Chem.*, 1930, Vol. 86, p. 17.

(5.) Pyle, S. Idell and C. Elton Huff. The use of three-day balance periods in human metabolism studies. Calcium and phosphorus. J. Nutrition, 1936, Vol. 11, p. 495.

(6.) Toverud, K. U. and G. Toverud. Studies on the mineral metabolism during pregnancy and lactation and its special bearing on the disposition to rickets and dental caries. *Acta Pediat.* (Supp. 2), 1931, Vol. 12, p. 1.

# GEOGRAPHIC AND TIME VARIATIONS IN BODY GROWTH AND AGE AT MENARCHE

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THAT the last few decades have witnessed a wide-spread betterment in human growth and nutrition now seems to be beyond doubt. From countries on practically all continents has come evidence of increased stature and better physique. And in most instances credit for the improvement has been claimed by those advocating higher standards of diet and hygiene for the individual and for the mass. Experimental studies in animal nutrition have seemed to provide a sound basis for these claims, since growth and development could readily and surely be influenced by dietary means. It has only been by inference, however, that these findings have been applied to human populations. Many tropical peoples, it is true, live on diets that are definitely inadequate for the much more energetic inhabitants of stormy temperate regions, but are we justified in applying temperate zone dietary standards to people living under tropical moist heat?

Data collected in recent years on growth and development in both man and animals would seem to indicate that the role of diet may be secondary to the ease or difficulty of heat loss from the body. Energy for accomplishment or growth is inseparably linked to heat production, so that conditions rendering heat loss from the body difficult must result in corresponding suppression of total body function. Great ease of heat loss, on the other hand, stimulates growth and development, and imbues a people with an irrepressible energy that must be always seeking outlets in action. This stimulation can, however, be carried too far and produce a metabolic exhaustion that progressively lowers the efficiency of body functions. These statements are not unwarranted generalizations, but have as their basis definitely established research findings.

Some years ago Baldwin (1) published graphs showing growth curves for school children of various countries, and on these it was seen that children of the stormy temperate regions maintain a constant and quite marked lead over the growth of those residing under tropical or subtropical climates. Northern United States and Central Europe surpass in both height and weight. At St. Louis growth lags behind Milwaukee standards, and at Turin, Italy, there is evident a marked inferiority to central European standards. In regions of tropical moist heat, such as the Philippines, or in Oriental countries, where the prolonged moist heat of the severe monsoon summer dominates the climatic picture, growth and development are most retarded and adult stature lowest. In India the same striking differences are seen when one compares the people of the lowlands, blanketed under depressing moist heat, with the natives of the more invigorating dry uplands in Northwestern India. Such growth variations in population groups have usually been attributed to dietary differences, for people living under moist heat do tend to restrict their protein intake and subsist more on carbohydrate foods that call forth less body heat production in their assimilation.

With man the role of diet has been difficult of evaluation, but with laboratory animals Ogle (2) has provided illuminating data. She has shown beyond a doubt that body growth and development are retarded by tropical moist heat conditions that render body heat loss difficult. This occurs even though the living conditions otherwise, and the diet, are kept at the same optimal level that produces excellent growth at lower temperatures which permit ready loss of body heat. The unequivocal results she has obtained, showing how clearly the ease or difficulty of heat loss from the body dominates such basic functions as those of growth and sexual development, leave little doubt as to the role climatic environment must play in human development of different regions.

Perhaps the most significant criterion of body development, after growth itself, is the onset of the menses in females. Both Boas and Shuttleworth, in papers delivered at the 1936 Anthropological Meetings in New Haven, presented evidence of a close linkage of menarche to growth, the menses usually beginning at or near the growth peak of puberty. It is of considerable interest, therefore, to see if the onset of the menses in various population masses bears any relationship to growth rate. There must first be discarded the idea, world-wide and

centuries old in its acceptance, that girls mature earlier in the tropics than in temperate regions. Careful analysis of statistics provides no support for this universally held belief. In fact quite the reverse has been found true, for in those regions of tropical moist heat, where body growth lags most, the menses are found to start distinctly later than in the invigorating temperate zones.

When we come to a close investigation of the onset of the menses over the earth, several factors must be considered. In practically all countries the menses now begin definitely earlier than was the case a half century ago. In the following data this contrast is well brought out.

| *Of 575 Cincinnati women aged now (1935)* (*years*) | | *Mean age at onset of menses was* (*years*) |
|---|---|---|
| 24 | under 20 | 13.13 ± 0.22 |
| 78 | 20-29 | 13.77 ± 0.11 |
| 125 | 30-39 | 14.09 ± 0.10 |
| 118 | 40-49 | 14.29 ± 0.11 |
| 97 | 50-59 | 14.75 ± 0.14 |
| 62 | 60-69 | 14.76 ± 0.14 |
| 48 | 70-79 | 14.67 ± 0.17 |
| 22 | 80-89 | 14.77 ± 0.34 |
| 1 | 91 | in her fifteenth year |
| *Filipinos at Cebu* | | |
| 64 | under 20 | 14.48 ± 0.11 |
| 65 | 20-29 | 15.59 ± 0.14 |
| 76 | 30+ | 15.71 ± 0.11 |

Similar data on Filipinos in Manila, Chinese at Hongkong, negroes at Panama, both negroes and whites at Richmond, Baltimore and Cincinnati, and on university girls at Cincinnati and Minneapolis, in every case verified this distinct tendency toward earlier onset of the menses. It is evident then that no comparisons of age at menarche should be made without consideration of the subjects' age and the changing trend.

In Norway, while Husemann (3) in 1868 found the age at menarche to be 16.1 years, Skerlj (4) in 1935 found it to be around 14.5 years. In Munich it was 16.3 years in 1864, but 15.4 years in 1880 (5). At Göttingen in southern Germany it was 16.6 years in 1795 (6), while nearby at Giessen it was 14.5 years in 1920 (7). Girls in Spain and Italy now come to the menarche mainly in their sixteenth year, but in ancient Greece menstruation began largely in the fourteenth year according to Hippocrates.

Unfortunately few people, studying or writing on this subject, have recognized these changing trends in puberty age and rate of body development, so that great confusion has arisen in the literature. Regional differences in development have been mixed with time differences and the subject thoroughly muddled.

Social condition and nutritional state also affect the onset of the menses. City girls mature earlier than those from the country, the

*Recent data on age at onset of menses*

| *Regions outside of North America* | *Years* |
|---|---|
| Philippine Islands | |
| 205 Filipinos at Cebu (Rodriguez, 1935) | 15.29 ± 0.07 |
| 636 Filipinos at Manila (Mills, 1935) | 14.77 ± 0.04 |
| Honkong | |
| 464 Chinese women (Mills, 1935) | 15.21 ± 0.05 |
| Canton | |
| 2291 Chinese women (Chau & Wright, 1925) | 14.84 ± 0.03 |
| Fukien | |
| 599 Chinese women (Maxwell, 1920?) | 15.44 ± 0.11 |
| Formosa | |
| 136 Chinese women (Yamasaki, 1909) | 16.65 ± 0.11 |
| Japan | |
| 1526 Hondo Japanese women (Yamasaki, 1909) | 14.73 ± 0.02 |
| 3085 Kyusyu Japanese women (Yamasaki, 1909) | 15.00 ± 0.02 |
| 250 Shikoku Japanese women (Yamaski, 1909) | 14.80 ± 0.06 |
| 184 Riukiu Japanese women (Yamasaki, 1909) | 16.42 ± 0.10 |
| Panama | |
| 188 negro women (Mills, 1935) | 14.13 ± 0.06 |
| Brazil | |
| 9010 San Paulo women (Mattos, 1934) | 14.63 ± 0.01 |
| 1191 Bahia women (Netto, 1933) | 13.77 ± 0.03 |
| 451 Rio de Janeiro women, white (Castro, 1912) | 14.47 ± 0.05 |
| 1646 White women, various cities (Castro, 1912) | 14.23 ± 0.03 |
| Ecuador | |
| 367 Lima women, white (Arrieta, 1932) | 14.01 ± 0.06 |
| Cuba | |
| 100 White women (Mathé, 1911) | 13.87 ± 0.07 |
| Spain | |
| 1970 Asturian women (Torres, 1932) | 15.89 ± 0.03 |
| Italy | |
| 246 Italian women of Milan (Torres, 1932) | 15.16 ± 0.07 |
| Calcutta | |
| 268 Hindu women (Curjel, 1920) | 14.12 ± 0.07 |
| 140 Mussulman women (Curjel, 1920) | 14.14 ± 0.10 |

*Recent data on age at onset of menses (continued)*

| *Regions outside of North America* | *Years* |
|---|---|
| 81 Indian Christian (Curjel, 1920) | 14.19 ± 0.11 |
| 56 Indian College girls (Curjel, 1920) | 14.38 ± 0.14 |
| Czechoslovakia | |
| 9949 Prague women (Dworzak, 1935) | 14.46 ± 0.01 |
| France | |
| 438 Paris women (Vignes, 1929) | 13.55 ± 0.05 |
| Amsterdam | |
| 1800 Dutch women (Bolk, 1923) | 14.06 ± 0.03 |
| Germany | |
| 770 Giessen women (Deiterich, 1920) | 14.49 ± 0.04 |
| Norway | |
| 4502 Norwegian women (Skerlj, 1935) | 14.5 |
| Scotland | |
| 10219 Edinburgh women (Kennedy, 1933) | 15.04 ± 0.01 |
| Finland | |
| 3596 Finnish women of Helsinki (Malmio, 1919) | 15.95 ± 0.04 |
| Russia | |
| 434 Russian women (Herstein 1917-23) | 15.85 ± 0.05 |
| *North America* | |
| New Orleans | |
| 329 High School and Univ. girls (Gould, 1930) | 13.53 |
| Richmond | |
| 134 white women (Mills, 1935) | 14.02 ± 0.09 |
| 182 colored women (Mills, 1935) | 13.80 ± 0.07 |
| Baltimore | |
| 127 white women (Mills, 1935) | 14.14 ± 0.11 |
| 109 colored women (Mills, 1935) | 13.60 ± 0.09 |
| Pennsylvania State College girls, 222 (Ritenour, 1934) | 13.41 ± 0.05 |
| Cincinnati | |
| 1069 Univ. freshman girls (1930-5) | 13.34 ± 0.02 |
| Lexington | |
| 157 Univ. of Kentucky girls (Chambers, 1934) | 12.99 ± 0.07 |
| Columbia | |
| Univ. of Missouri girls (Stine, 1934) | 13.00 |
| Minneapolis | |
| Univ. of Minnesota girls (1934) | 12.8 |
| Montreal | |
| 200 white women (Mills, 1935) | 13.8 |
| St. Johns, New Brunswick | |
| 500 white women (Mills 1935) | 14.1 |

*Note*: All mean ages given above or referred to in this paper were calculated by the author from original case data by a uniform and correct method of calculating the mean and its probable error. All ages have been placed on an American basis of stating age, which means that from all Chinese ages one year has been deducted.

difference being about one half year on the average (5). Malnutrition may, and often does, produce marked retardation in onset of the menses (8). In the data given below, however, most of the subjects were well people, maternity cases in charity hospitals. Cases on hospital gynecological services were also used to some extent, but close check showed the menarche to come at practically the same mean age in obstetrical and gynecological cases.

Keeping in mind the world-wide trend toward earlier menarche, let us now compare recent figures that are available in different countries.

It seems fairly safe to say that nowhere on earth do girls mature so early as they now do in the central part of North America. The mean menarche age for University girls of the Middle West is now about 13 years, with the trend toward earlier years still in evidence. Among the entering freshman class of 1935 at the University of Cincinnati, there were 62 girls 17 years of age with a mean age at menarche of $12.94 \pm 0.09$ years, and 4 girls 16 years of age whose average age at menarche was 12.5 years. In this same area body growth is also most rapid, in live stock as well as in children. South toward the Gulf of Mexico, east toward the Atlantic coast, or northeast into Canada, the menses tend to begin at later ages. In the Caribbean region and throughout South America the development of puberty is delayed about one year, while throughout all the rest of the tropics except India the lag is fully two years behind the standard prevailing in our Middle Western States.

European people show a somewhat similar picture. In the subtropical countries bordering the Mediterranean sea development is *not* most rapid, as it has always been pictured, but is relatively slow, with the menses starting mainly in the 16th year. In the more stormy and energizing climate of west central Europe, development is more accelerated, with the menses coming a year to a year and a half earlier. Farther to the north or east (Finland and Russia) the long periods of benumbing cold retard development to much the same degree as does tropical heat.

The stimulation of climate also shows in another phase of sex development,—the onset of fertility. Fertility in girls seldom comes with the onset of the menses. Perhaps one in twenty are capable of conception at that time. Godin (9) has stated that the lag in fertility lasts about five years after the menses begin, but he gives no data. In a very recent study (10), however, it has been shown that this

sterile period is of variable length, being progressively shorter the earlier the menses begin in people of different geographic groups.

| | *Menses began at years* | *First delivery at years* | *Lag in fertility (menarche to first conception) years* |
|---|---|---|---|
| 84 Filipino girls, married ..... | 14.58 | 21.88 | 6.55 |
| 22 Filipino girls, unmarried ..... | 14.73 | 21.82 | 6.33 |
| 72 Panama negro girls, unmarried ..... | 14.04 | 19.26 | 4.47 |
| 56 Richmond negro girls, unmarried .... | 13.46 | 18.21 | 4.00 |
| 33 Cincinnati negro girls, unmarried..... | 13.44 | 18.08 | 3.89 |

The constant shifting of the onset of puberty in American youth toward earlier years raises many questions, especially regarding growth and adult height. Girls usually grow little here in America after the second year of menstrual activity, cessation of growth of the long bones probably coinciding rather closely with the onset of true sexual fertility. During past decades, while the period of childhood growth has been shortening, the *rate* of growth has been greatly increased through the application of more effective nutritional standards. However, in the last ten years little further advance has been made in the nutritional state of children, so that we may expect soon to witness a decline in the adult height, particularly of women. Boys grow for a considerably greater part of adolescence than do girls, so that less change is to be expected in their adult height.

From the above statistics on the onset of the menses, it is seen that here in the United States some factor in life is producing a stimulation of growth and sexual functions far in excess of that seen anywhere else on earth. It is certainly suggestive that this should be happening in the country with the most intense climatic drive, and that here in America the change should be proceeding most rapidly in our most stimulating north central states. These same changes can be produced in laboratory animals by subjecting them for a few weeks to artificial climatic stimulation under controlled conditions (2). We may, therefore, accept as a fact this change in development, with the marked shortening of the period of childhood.

Geographic differences in body development are also illustrated by height and weight data on college girls. Arranging the data* from American colleges according to standing height:

*Most of the data used here were taken from Diehl's excellent monograph (11).

| | *Inches* |
|---|---|
| Univ. of Nebraska, Lincoln, Neb. | 62.8 |
| Michigan State Normal | 63.1 |
| Cornell Univ., Ithaca, N. Y. | 63.4 |
| Michigan Univ., Ann Arbor, Mich. | 63.4 |
| Univ. of Minnesota, Minneapolis, Minn. | 63.5 |
| Univ. of Kentucky, Lexington, Ky. | 63.6 |
| Univ. of North Carolina, Chapel Hill, N. C. | 63.7 |
| Univ. of Cincinnati, Cincinnati, Ohio | 63.9 |
| Univ. of Texas, Austin, Texas | 63.9 |
| Univ. of Wisconsin, Madison, Wis. | 63.9 |
| Tulane Univ., New Orleans, La. | 64.0 |
| Univ. of Illinois, Urbana, Ill. | 64.0 |
| Univ. of Kansas, Lawrence, Kan. | 64.1 |
| Univ. of Washington, Seattle, Wash. | 64.2 |
| Smith College, North Hampton, Mass. | 64.2 |
| Pennsylvania State College. State College, Pa. | 64.4 |
| Leland Stanford Univ., Stanford, Cal. | 64.4 |
| Vassar College, Poughkeepsie, N. Y. | 65.0 |
| Bryn Mawr, Bryn Mawr, Pa. | 65.6 |
| Univ. of Philippines, Manila, P. I. | 58.0 |

In general the standing height of American college girls is least in the upper Mississippi basin where puberty has such an early onset; it is perhaps slightly greater in the lower half of the basin; but along both the east and the west coasts definitely greater heights are attained by both men and women. The relation, however, of these differences in height to general body nutrition is another matter entirely. Arranging the colleges according to the weight of the freshman girls, the following order is found.

| | *Pounds* |
|---|---|
| Univ. of Texas, Austin, Texas | 116.0 |
| Univ. of Kentucky, Lexington, Ky. | 116.1 |
| Univ. of North Carolina, Chapel Hill, N. C. | 117.3 |
| Univ. of Kansas, Lawrence, Kan. | 117.6 |
| Univ. of Nebraska, Lincoln, Neb. | 118.8 |
| Tulane Univ., New Orleans, La. | 119.6 |
| Univ. of Illinois, Urbana, Ill. | 119.6 |
| Michigan State Normal | 120.0 |
| Univ. of Cincinnati, Cincinnati, Ohio | 120.2 |
| Univ. of Michigan, Ann Arbor, Mich. | 120.5 |
| Univ. of Wisconsin, Madison, Wis. | 121.3 |
| Univ. of Minnesota, Minneapolis, Minn. | 121.6 |

| | |
|---|---|
| Cornell Univ., Ithaca, N. Y. | 123.2 |
| Leland Stanford Univ., Stanford, Cal. | 123.8 |
| Smith College, North Hampton, Mass. | 123.9 |
| Vassar College, Poughkeepsie, N. Y. | 125.2 |
| Univ. of Washington, Seattle, Wash. | 125.6 |
| Pennsylvania State College, State College, Pa. | 127.0 |
| Bryn Mawr, Bryn Mawr, Pa. | 128.1 |
| Univ. of Philippines, Manila, P. I. | 105.6 |

College girls of the South are lowest in body weight, those of the north central states next, and those of the east and west coasts heaviest. If now a simple ratio be obtained between height in inches and weight in pounds (ratio $= \frac{\text{height}}{\text{weight}}$), the resultant index of body build (Fig. 1) shows greatest robustness in the north and an increasing slenderness of form toward the Gulf region.

This same relationship of body form to climatic stimulation is in general well brought out by Nañagas and Santiago (12) in their data on college men of various races and countries as given below. Body weight per unit of height is lowest in regions of tropical moist heat, next lowest in sub-tropical climates and highest in the cool stormy temperate regions.

| *University men* | *Height in centimeters* | *Grams of weight per centimeter of height* |
|---|---|---|
| Southern Chinese | 163.1 | 310.4 |
| Filipinos of Manila | 163.3 | 311.0 |
| Japanese | 159.7 | 349.0 |
| Northern Chinese | 167.1 | 354.8 |
| Koreans | 162.2 | 361.7 |
| Hebrew | 166.9 | 376.6 |
| Irish | 171.4 | 379.2 |
| Italian | 165.2 | 379.3 |
| Scotch | 172.5 | 382.2 |
| English | 172.1 | 382.3 |
| French | 168.6 | 383.0 |
| Oxford | 176.5 | 389.2 |
| Polish | 169.4 | 390.8 |
| German | 172.0 | 390.8 |
| Stanford | 175.9 | 390.8 |

FIG. 1. HEIGHT-WEIGHT RATIOS OF AMERICAN COLLEGE GIRLS

Human data on childhood growth and adult body size and form are thus seen to agree with those obtained from experimental animals kept under controlled conditions of artificial climates, and with the growth of domestic livestock. We apparently are dealing with a general biologic phenomenon. It would seem that greatest size and robustness of form tend to come where the climate is stimulating and heat loss from the body readily accomplished. Human beings or animals, living under conditions of moist heat, grow less well and assume distinctly more slender body form. In the north central states of America, however, where climatic stimulation is extreme for a good part of each year and where puberty comes on earliest, growth in height is halted so early as to give an adult stature inferior to that of other temperate regions, although the body form is as robust as is anywhere seen.

We must give up the belief held for decades over the whole earth that bodily and sexual maturity comes earliest in tropical countries and is later in temperate regions. Carefully collected statistics show the exact reverse to be the case. We may now say with a fair degree of certainty that in both animals and men growth and bodily development proceed most rapidly in regions of greatest climatic stimulation, and that in regions of depressing moist heat there is evident a progressive lag proportional to the depressing effects of the stagnating heat. Sexual maturity in tropical countries comes fully two years later than in the most stimulating temperate regions. These facts should be kept in mind by geneticists and others interested in racial improvement, for therein may lie the principal basis of many racial differences. That our white stock in America, and the negroes North and South, should show the differences just as definitely as do those of varying racial stock in other climatic regions of the earth is proof that climate is a factor of basic importance. It would thus seem to be climatic drive, working through the centuries, that probably accounts for many racial differences in build and body development.

There are several indications that human advance comes in long undulations of progress and recession, and that these waves are truly biologic and based on some extra-terrestial force affecting man. In the time of ancient Greece there occurred a crest somewhat similar to the present. In stature and body build the ancient Greeks were the equal of, or perhaps superior to, present day people, and Hippocrates stated that the menses usually began at the age of 13. In philosophy

and power of cerebration, in literature and art, in government, and in many other ways, evidence indicates an ancient Grecian crest in human development comparing very favorably with the most advanced groups of today. Through the intervening centuries of darkness and recession, however, man slumped in form and achievement. The giants and warriors of the Middle Ages were mere pigmies compared to present day military standards, for a twelve-year-old American boy of today can scarcely get into their suits of armor. Body height of men during this period seems to have receded to about the level of prehistoric man (5 ft. 1 to 2 inches). Even early in the 19th century the average male height in England was 3 inches less than it is today. Shortness of stature and slenderness of form were matched also by lateness in onset of puberty, records of over a century ago showing an onset of the menses usually in the 17th or 18th year, except for the people of France.

The last 70-80 years, though, has witnessed a quickening in many phases of human affairs. Birth size has increased, speed of growth and body development has been accelerated, adult stature and robustness of form augmented, along with such outburst of inventive and scientific advancement as had not been witnessed since the time of Grecian glory. The tremendous acceleration in world population growth during this same recent period has brought much nearer the necessity of considering future over-population problems, for in one century the human race has almost doubled the numbers it had amassed through all the preceeding ages. Is there any evidence at hand to indicate whether this growth is to continue and plunge us, within another century, into devastating over-crowding? Here, it would seem, is where recent findings may be brought into valuable use, for the close linkage between body growth, speed of development and reproductive fertility on the one hand, and environmental stimulation and temperature level on the other, provides us with a logical basis from which to consider the problem.

The low point of recent centuries in world temperatures was reached about 1850-1860. An irregular but slow rise occurred through the subsequent six decades, but since 1920 temperatures have pointed upward much more emphatically throughout the world. The recent world-wide heat wave of 1929-34 has probably carried us back close to the temperature level of the Middle Ages, for Viking bodies were excavated in 1933 from Greenland earth that had been solidly frozen for

the intervening centuries. Coincident with the cold of last century came the sudden outburst of population growth and general activity that carried civilization forward so impetuously to its recent crest.

Since 1920, however, recession has set in. This most recent period has seen a tapering off in population growth in several of the most prolific peoples of former decades. Widespread growth and acceptance of contraceptive practices has also occurred, and probably represents only an early form of decline in racial reproductive potential. It would seem that more and more people in various lands are becoming willing to let their urge toward racial reproduction be subdued by economic considerations. The urge to reproduce must indeed be subsiding when it allows itself to be pushed aside for mere physical enjoyment and ease of existence.

We have shown in previous papers (13, 5, 10) how a rise of mean temperature level produces a prompt diminution in fertility in either man or animals, and how reproductive functions respond to optimal coolness. Is it not possible that world population growth may be governed by these same biologic principles? Observations over a few more years will provide the answer, for girls born since 1920 are now entering puberty and, if the effects of rising world temperatures are as discussed in these pages, we should soon see a reversal in trend of puberty onset toward later instead of earlier ages.

## SUMMARY AND CONCLUSIONS

During the last half century there has been a world-wide quickening in body growth, accompanied by a definite trend toward earlier onset of the menses. Adult height and weight are both greater than they were fifty years ago, and markedly in excess of Middle Age body size. According to Hrdlička, however, present day man has not yet quite reached the size developed in such ancient civilized groups as the early Egyptians or the early Indians of the southwest.

The menarche age has seemed to fluctuate with changes in rate of body development, for in ancient Greece, where physical development was so good, the menses began at the same early age as is happening in the most advanced groups of today, while with the physical slump of the Middle Ages came a great retardation in menarche.

Geographical differences in growth and age at menarche also go hand in hand. In regions of depressing moist heat, both growth and menarche are delayed, and the final adult form is slender and small.

In the stormy temperate regions, on the other hand, growth is most rapid, the menses begin earliest, and the most robust body forms are seen. Exactly similar differences have been produced in laboratory animals under conditions of careful control, where the ease or difficulty of body heat loss has been found to be the chief determining factor in speed and type of body development. Adequacy of diet cannot overcome the physical retardation that comes with difficulty of body heat loss.

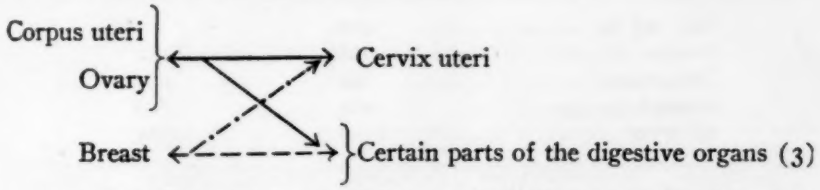
## BIBLIOGRAPHY


1. Baldwin, B. T. Physical growth and school progress. *U. S. Bureau of Education*, Buli. 10, 1914.
2. Ogle, Cordelia. Climatic influence on the growth of the male albino mouse. Adaptation of sexual activity to environmental stimulation. *Amer. Jour. Physiol.*, 1934, 107, pp. 628-640.
3. Husemann, T. Normales Verhalten der Menstruation in Norwegen. *Monatsbl. f. med. Statist. u. öff. gsndhtspflg., Berlin*, 1868, pp. 24-28.
4. Skerlj, B. Die Menarche in Norwegen und ihre Beziehungen zum Klima. *Arch. f. Gynaek*, 1935, 159, 12-21.
5. Schlichting, F. X. Statistisches über den Eintritt der ersten Menstruation und über Schwangerschaftsdauer. *Arch. f. Gynaek., Berlin*, 1880, 16, 203-232.
6. Osiander, F. B. Resultate von Beobachtungen und Nachrichten über die erste Erscheinung des Monatlichen. *Denkwrdgktn. f. d. Heilk. u. Geburtsh. Göttingen*, 1795, II, 380-388.
7. Dieterich, H. Die Menarche in ihrer Beziehung zur Menstruation ur. Fruchtbarkeit des Weibes. *Giessen*, 1920.
8. Dworzak, H. Rachitis und Menarche. *Med. Klin., Berlin*, 1936, 32, 17-19.
9. Godin, Paul. Quoted in Vignes' "Physiologie Gynécologique." *Paris*, 1929, p. 55.
10. Mills, C. A., and Cordelia Ogle. Physiologic sterility of adolescence. Human Biology, 1936, 8, 607-615.
11. Diehl, Harold S. The heights and weights of American college women. Human Biology, 1933, 5, 600-628.
12. Nañagas, Juan C., and Leon C. Santiago. Vital capacity and physical standards of students of the University of the Philippines. *The Philippine Jour. Science*, 1927, 32, 325-359.
13. Mills, C. A., and F. A. Senior. Does climate affect the human conception rate? *Arch. Int. Med.*, 1930, 46, 921-929.

# FURTHER STUDIES ON THE ROLE OF IRRITATION IN CANCER[1]

BY SIGISMUND PELLER, M.D.

IN A recent paper (1) I stated that there are many statistical findings incompatible with the common conception on the relations between irritation and cancer. Increasing the amount of certain carcinogenic irritations in a population group we increase—as is well known—the number of cancer cases at the irritated spots. But simultaneously the frequency of tumors in some other organ decreases. This cannot be explained if the carcinogenic irritation affects only the directly afflicted part of the body. The decrease is sometimes as large as the increase in the additionally irritated organ, sometimes smaller. Thus the total cancer frequency in a population exposed to more carcinogenic irritations remains unchanged or rises. In both cases there is a real change in the distribution of the primary tumors, a real shifting of the incidence. This effect of carcinogenic irritation was unknown until discovered by my statistical studies on the relations between pregnancy and cancer. These studies were not in accord with the localized traumatic theory (2) and indicated that the biological and physiological processes accompanying (or hindering) pregnancies do not change the total cancer frequency but only shift the locus of the later primary tumor between




Recently I was able to show the shifting function of carcinogenic irritations in the case of workers exposed to tar and alcohol (1).

[1]This paper was prepared while the writer was a guest investigator in the Department of Biology of the School of Hygiene and Public Health of the Johns Hopkins University.

According to English occupational statistics there is a contrast between the changes of cancer frequency in the skin and upper digestive tract. Finally I was able to demonstrate the shifting function of gall-stone irritation (postmortem statistics).

As long as we did not know that changes in cancer frequency in one spot lead to opposite changes in certain other places, we have had to urge a diminution of irritations in everyday life—at least a reduction of exposure to them—in dangerous occupations as the only means of cancer prophylaxis. Thus both Roffo (5) and a French committee (Hartman, Roussy and Beclère) have recently warned the people against exposing themselves to the sun's rays. But since skin cancer can be cured easily, and as by increasing skin cancer cases the more primary tumors of the tongue and oesophagus become less frequent, it is suggested that we should rather encourage people to take sun-baths.

The importance of the problem discussed demands further proofs and supporting examples. It is not easy to obtain them. Even in the occupational mortality statistics of England the figures are often too small and the differences not significant. There are also other difficulties. First of all we have to consider the inequality in the medical evidence. In a former paper (1) we studied the effect of *chemical* agents in certain occupations. Now we may examine the effects of

*Standardized cancer mortality per 100 thousand*

| | GLASSWORKERS | |
|---|---|---|
| | Exposed | Not exposed |
| LOCATION | to heat injury | |
| Skin and lip | 17.0 | 4.0* |
| Tongue | 10.6 | 12.2 |
| Oesophagus | 6.0 | 21.5 |
| Stomach | 30.0 | 31.9 |
| All other | 132.6 | 133.4 |
| Total cancer mortality | 196.2 | 203.0 |
| Number of person-years observed | 35925 | 28287 |

*Only one case; over 70 years old

*physical* carcinoma provoking factors as heat and fire, sun rays, and the pressure of the pipe stem.

In the English statistics (6) skilled glassworkers are divided into two groups. One of the groups is exposed to strong heat rays of the glass-melting furnace and to multiple burns. The other group does not suffer from these injuries. The first group has, as expected, much more skin cancer, but this excess is completely compensated for by a defect in the incidence of primary tumors of the internal organs. Thus the heat-injured workers are not at all worse off than the other glassworkers.

The total number of glassworkers is too small, about 21000 × 3 years) to make the difference significant. Thus I would not cite this example alone as convincing. But my former investigations have shown significant differences in the same direction. It may also be mentioned that among the glassworkers drinking is very common, which may account for the high frequency of cancer of the tongue and oesophagus among the group not exposed to heat. More astonishing, but now explicable, is the exceptionally low rate of cancer of the oesophagus and also the lower rate of cancer of the stomach among the workers exposed to heat. (The total group of skilled workers has a standardized mortality from cancer of the oesophagus of 11.3 ± 0.3 per 100 thousand.

The second example regards English labourers in forestry and agriculture. They belong to the lowest social group and have probably less efficient medical treatment than unskilled townspeople. Thus a large number of inaccessible cancers may remain unrecognized. But if we find that they have more skin and lip cancer and less cancer of tongue and oesophagus than, for instance, gardeners and their assistants, we cannot explain this contrast by the above mentioned medico-statistical

*Mortality from cancer (per 100 thousand)*

| AGE (*years*) | SKIN AND LIP | | TONGUE AND OESOPHAGUS | |
|---|---|---|---|---|
| | Forest and Agricultural labourers | Gardeners and Assistants | Forest and Agricultural labourers | Gardeners and Assistants |
| 35-44 | 1 | 1 | .. | 4 |
| 45-54 | 7 | 3 | 14 | 18 |
| 55-64 | 29 | 13 | 32 | 58 |
| 65-69 | 38 | 39 | 52 | 99 |
| 70 and over | 198 | 94 | 71 | 113 |

fault. Then we must think about real differences, perhaps caused by differential exposure to the sun and to pipe-trauma.

The sunlight in England is not as brilliant as in southern countries, where probably the differences in skin cancer frequency may be larger. As a matter of fact, the skin cancer mortality of the forest workers in England—500,000 men × 3 years—is not particularly high. It is higher than in the first, second, and third social class, but not higher than in the group of unskilled workers which contains the bulk of the workers exposed to tar, oil, and pitch. For this reason the effect of the combination of sun and pipe pressure* on the lip may be clearer than of the sun on the skin.

*Cancer of the lip. Mortality per 100 thousand*

| AGE (*years*) | FOREST AND AGRICULTURAL LABOURERS | SOCIAL CLASS | | | | |
|---|---|---|---|---|---|---|
| | | I* | II | III** | IV | V*** |
| 35-44 | 0.4 | .. | .. | .. | .. | .. |
| 45-54 | 2.4 | .. | .. | 1 | 1 | 2 |
| 55-64 | 14 | 2 | 3 | 3 | 8 | 8 |
| 65-69 | 16 | .. | 8 | 7 | 10 | 16 |
| 70 and over | 88 | 3 | 21 | 19 | 60 | 53 |

*The highest social class
**Skilled workers
***Unskilled workers

The forestry group suffers more from lip cancer than any of the five social groups into which the total male English population was divided. At the same time they have the smallest mortality from cancer of the tongue and the oesophagus, as we see from the English figures. The symptoms of a malignant growth of the tongue are so evident at the time of death that errors of diagnosis are probably not more frequent than in the cases of lip cancer. Futhermore, it is impossible to suppose that mouth hygiene is better among wood cutters than among other people. The forest workers do not have as much syphilis as the people in urban areas. This is important(8). However their teeth and gums are worse. As we see from the table, the better the social status,

*Some investigators doubt whether pipe pressure is a carcinogenic factor (Cf. J. Lane-Claypon (7)).

the lower the rate of cancer of the tongue, but the forest and agricultural labourers have a smaller rate than the wealthiest group.

Not all oesophagus cases are recognized as such. They may be partly hidden among the cases of cancer of the stomach. The poorer the people, the more likely are such errors. In order to eliminate this

*Cancer of the tongue. Mortality per 100 thousand*

| AGE (*years*) | FOREST AND AGRICULTURAL LABOURERS | SOCIAL CLASS I | II | III | IV | V |
|---|---|---|---|---|---|---|
| 35-44 | ... | 1 | 1 | 1 | 1 | 2 |
| 45-54 | 4·4 | 7 | 8 | 9 | 10 | 18 |
| 55-64 | 11 | 11 | 22 | 31 | 32 | 51 |
| 65-69 | 12 | 25 | 31 | 42 | 34 | 62 |
| 70 and over | 34 | 35 | 41 | 53 | 49 | 107 |

As to cancer of the oesophagus, the differences between the five social classes are not so great, but the trend is the same. The forestry labourers have a lower mortality from cancer of the oesophagus than even the socially best situated people (Class I), and evidently also lower than the men of the social group to which they belong.

*Cancer of the oesophagus. Mortality per 100 thousand*

| AGE (*years*) | FOREST AND AGRICULTURAL LABOURERS | SOCIAL CLASS I | II | III | IV | V |
|---|---|---|---|---|---|---|
| 35-44 | ... | 1 | 1 | 1 | 1 | 2 |
| 45-54 | 9 | 11 | 11 | 14 | 13 | 17 |
| 55-64 | 21 | 30 | 39 | 43 | 34 | 54 |
| 65-69 | 39·5 | 36 | 53 | 62 | 54 | 72 |
| 70 and over | 35 | 57 | 74 | 75 | 53 | 90 |

error we shall sum up the cases under both headings, oesophagus as well as stomach. If we now compare the forest and agricultural workers with the other manual labourers (social classes III, IV and V) the differences still exist, being percentually smaller than formerly. The differences disappear only if we compare the forest and agricultural labourers with the highest social group.

*Cancer of the oesophagus and stomach. Mortality per 100 thousand*

| AGE (*years*) | FOREST AND AGRICULTURAL LABOURERS | SOCIAL CLASS I | II | III | IV | V |
|---|---|---|---|---|---|---|
| 25-34 | 1 | 4 | 1 | 2 | 2 | 3 |
| 35-44 | 8 | 5 | 9 | 12 | 13 | 16 |
| 45-54 | 40 | 34 | 43 | 53 | 56 | 68 |
| 55-64 | 122 | 96 | 133 | 153 | 148 | 196 |
| 65-69 | 207 | 171 | 253 | 245 | 243 | 261 |
| 70 and over | 311 | 218 | 350 | 334 | 317 | 393 |

Therefore we may reasonably conclude that, among the forest labourers the mortality from skin and lip cancer is increased, whereas the frequency of cancer of the tongue and oesophagus is really diminished, even though in a smaller percentage than the official figures show. The excess in incidence for the skin and lip is overbalanced by the defect for the tongue and oesophagus. Thus we have to consider whether carcinogenic irritations act as a shifting and regulating factor primarily only after the tumor so caused appears macroscopically, or whether, under certain circumstances, already before such macroscopic appearance. No answer is yet available. We do not know anything about the mechanism of this regulating action. Is it a sort of immunization? Do the products of cancer cells prevent the development of cancer cells existing in other organs, which unhindered would grow into a second or third primary tumor, or do they prevent the transformation of normal cells in the other organs into cancer cells? The shifting rôle of the cancer provoking agents seems to show that there must be more than one single organ disposed to cancer production in the human body, and that there are perhaps close relations between the agents and the "disposition" itself. In spite of the great amount of work that has been done we do not know much about what "disposition" really is biologically. If it is no more that the reactivity of cells to proper carcinogenic or carcinoma provoking agents, we must conclude that it depends, among other things, on events *outside* the particular organ. Not only our statistical studies, but also recently published experimental findings point in this direction. Bittner (9) found that prohibiting of breeding prevents the appearance of mammary cancer in mice, but leads to the development of about the same number of tumors in the lungs, which formerly in the female of this strain seemed not to be disposed to

cancer. The lack of oestrin which stimulates the proliferating processes in the mammary glands results in the breast becoming unable to produce a cancer. But oestrin produces no effect whatever upon the lungs. In his experiments Bittner apparently increased the "disposition" in a non-afflicted organ, whereas in the experiments of both Dobrovolskaja-Zavadskaja (10) and Cramer (11) the opposite result was attained. Although the experiments mentioned do not justify conclusive assertions, they support our view. Especially the paper of Bittner seems to be important because he did not work with any intoxicating material, nor with tar or hormones which, when applied in great quantities, disturb the chemical milieu of the body and produce conditions very far from those in human beings. Bittner's experiment has its analogy in human pathology, i.e., in the conditions among *single* nulliparae. Concerning the distribution of cancer in the genital organs these women differ, as I have been able to show, from women who had been pregnant, and differ from them more than do *married* nulliparae. It would be very interesting to see whether there are also differences in cancer incidence in other parts of the body.

*Absolute and relative distribution of cases of uterine and ovarian cancer*
(Experience 1913-22 of Universitätsfrauenkliniken des Wiener Allgemeinen Krankenhauses)

| LOCATION | NUMBER OF CANCER CASES | | | | | |
|---|---|---|---|---|---|---|
| | Nulliparae | | | | Have been pregnant | |
| | Single | | Married | | | |
| | Abs. No. | Percent | Abs. No. | Percent | Abs. No. | Percent |
| Cervix uteri ..... | 44 | 37 | 95 | 51 | 1813 | 76 |
| Corpus uteri and ovary... | 74 | 63 | 90 | 49 | 566 | 24 |
| Total ..... | 118 | 100 | 185 | 100 | 2379 | 100 |

## CONCLUSIONS

1. The investigation on workers exposed to strong heat rays, burns, sun and pipe-stem injuries confirms our previous conclusions. The carcinoma provoking agents lead not only to a changed incidence of cancer in the irritated spot, but also to opposite changes in some of the other organs to which they have no relation.

2. There appears to be an antagonism in respect of cancer incidence (a) between the skin and the upper alimentary tract; and (b) between the corpus uteri-ovary-breast on the one hand and the cervix uteri and certain parts of the digestive organs on the other hand.

3. Through a purposely changed amount of irritation in one organ an active transfer of primary tumors into certain other organs has to be possible. Further studies will show whether this possibility can be utilized from the point of view of the cancer campaign.

## REFERENCES

(1.) PELLER, S. *The Lancet*, 1936, Vol. 231, p. 552 (5/ix).
(2.) PELLER, S. *Wien. klin. Wochenschr.*, 1922 (Nos. 6-8), Vol. 35, p. 121.
(3.) PELLER, S. *Zeitschr. f. Krebsforschg.*, 1929, Vol. 28, p. 266 (together with W. STÖHR).
(4.) PELLER, S. *Klin. Wochenschr.*, 1936, Vol. 15, p. 217.
(5.) ROFFO, A. H. *The Lancet*, 1936, Vol. 230, p. 472 (29/ii).
(6.) The Registrar-General's Decennial Supplement; England and Wales 1921; London, 1927.
(7.) LANE-CLAYPON, J. Cancer of the lip, tongue and skin. H.M. Stationary Office; Reports on Public Health, 1930.
(8.) LUND, CH. C. *New England Med. Jour.*, 1933, Vol. 209, p. 131.
HARDING, WARREN G. *Jour. of the Canc. Res. Comm. of Sydney*, 1936, Vol. 7, p. 137.
(9.) BITTNER. *Amer. Jour. of Cancer*, 1936, Vol. 27, p. 519.
(10.) DOBROVOLSKAJA-ZAVADSKAJA, N. *Compt. rend. Coc. de Biol.*, 1935, Vol. 119, p. 83 and p. 360.
(11.) CRAMER, W. *Jour. Path. and Bact.*, 1936, Vol. 14, p. 77.
(12.) PELLER, S. *Arch. f. Gynäk.*, 1923, Vol. 118, p. 59.

# VARIATION IN PARITY OF WOMEN BEARING CHILDREN IN THE U. S. BIRTH REGISTRATION AREA IN 1930. PART I [1]

BY RAYMOND PEARL

## I. ORIENTATION

IN CONNECTION with the comprehensive study of human fertility in progress in this laboratory it became desirable to know, as accurately as possible, the ordinal number of the pregnancy that was being experienced by women of specific ages who became pregnant in any particular year. Such information will obviously have important bearings upon a number of aspects of the general problem of fertility. In the first place the number of women who become pregnant and bear children in any particular year is only a fraction of the number who are potentially capable physiologically of doing so. This fact at once raises a series of questions concerned with the general problem of the proportion of expressed group fertility in any given short period of time (say one year) that the multiparae—the more or less habitual breeders—are responsible for, as compared with the primiparae—the tentative first experimenters in the reproductive field. Another set of questions relates to the comparative behavior in this respect of the different broad nativity or racial groups for which data are available. Still another is concerned with the comparative ordinal numbers of pregnancies resulting in live births and those resulting in stillbirths. Are they identical, or do they differ by amounts statistically significant?

Certain aspects of these problems have been discussed in an earlier paper[2], of which this one may be regarded as a continuation.

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[1]From the Department of Biology of the School of Hygiene and Public Health, Johns Hopkins University. It is a pleasure to express here my thanks to Mrs. Augusta K. Hibbitts and Dr. John R. Miner for their aid in the preparation of the material for this paper.

[2]Pearl, R. Potential and actual reproductive performance in man. HUMAN BIOLOGY, Vol. 8, pp. 508-530, 1936.

The present paper deals particularly with the ordinal number of births and related questions on the basis of the officially recorded reproductive experience in 1930 of women in the U. S. Registration Area, which in that year included all the states in the country except Texas and South Dakota. All the data used in this paper are derived from the annual volume of birth statistics for 1930 except as otherwise noted[3]. The official records are unfortunately not uniformly tabulated for the whole Registration Area, and therefore their usefulness is diminished in a manner presently to be explained in detail.

General Table 6 of the 1930 birth report cited gives "births (exclusive of stillbirths)", that is *live births,* by number of child and age of mother in single years, but "exclusive of Colorado, Maine, Massachusetts, New Hampshire, and Rhode Island" (p. 232). Table 14 gives corresponding information for stillbirths "exclusive of Massachusetts, Rhode Island, and New York", but in quinquennial instead of single year age groups. Obviously it is posible to compile the data in each of these tables the other way about, so that instead of having, as in the original report, the frequency of mother's ages for births of specified numerical order, we shall have frequencies of ordinal birth numbers for mothers of specified ages. This transformation was the first step in the investigation. Unfortunately, because of the "exclusions" noted above, that do not tally geographically, it is impossible to combine the two resulting live and stillbirth distributions into one total distribution. Therefore it is impossible to discuss even approximately the parity-age distribution of *pregnancies.* Instead we are necessarily confined to the treatment *separately* of the parity-age distribution of live births and of still births, with, in each case, only the material available for the class by itself.

The total material discussed includes 2,058,277 live births and 70,574 stillbirths, or 2,128,851 births in total. This latter number is smaller than the total births of the year, by reason of the omission of births for which the mother's age, parity, nativity, or some combination of these failed of record, and also because of the exclusion of states in the tabulations as already noted.

While the present paper is confined to the discussion of the statistics of a single year (1930) it should be understood that any other nearby year would show substantially the same results, indeed

[3]Bureau of the Census. Birth, Stillbirth, and Infant Mortality Statistics... 1930. *Washington* (Gov't. Printing Office) 1934. Pp. iv + 400.

so nearly identical in respect of all *relative* figures as to make it certain that no conclusion would be different in even the smallest degree.

### II. FIRST BIRTHS

Other factors being equal it is generally true for a given population and time that a declining crude birth rate has associated with it an increase in the proportionate number of first births to all births. This relationship is to be expected in a population where the practice of contraception is prevalent and increasing, because under such conditions women tend after their first successful pregnancy either to have no more at all, or only after a greater lapse of time than would be the case if reproduction were wholly unrestricted. Such procedure naturally tends to weight the births of any particular year unduly heavily with first births.

Let us begin the analysis of parity relations, therefore, with an examination of first births in 1930. Table 1 gives the percentages of first births to all births in each marginally defined age-race(color) category.

TABLE 1

*Percentages of first births to all births in the defined age-nativity-color-viability class; 1930*

| MOTHER'S AGE (*years*) | TOTAL WHITE | | NATIVE WHITE | | FOREIGN-BORN WHITE | | COLORED | |
|---|---|---|---|---|---|---|---|---|
| | Live | Still | Live | Still | Live | Still | Live | Still |
| 10-14 | 99.6 | 100 | 99.6 | 100 | 100 | ... | 99.7 | 100 |
| 15-19 | 79.3 | 83.0 | 79.3 | 83.1 | 78.5 | 79.4 | 72.5 | 69.7 |
| 20-24 | 46.4 | 57.3 | 46.0 | 57.3 | 51.0 | 56.5 | 29.3 | 32.8 |
| 25-29 | 24.8 | 33.8 | 24.3 | 33.7 | 28.0 | 35.2 | 10.4 | 13.7 |
| 30-34 | 12.3 | 19.6 | 12.3 | 20.0 | 12.2 | 17.5 | 5.2 | 7.3 |
| 35-39 | 5.9 | 10.6 | 6.4 | 11.4 | 5.3 | 7.6 | 3.0 | 5.7 |
| 40-44 | 3.4 | 6.5 | 3.7 | 7.5 | 2.6 | 3.3 | 1.8 | 5.1 |
| 45-49 | 2.5 | 4.9 | 2.7 | 5.4 | 1.7 | 3.5 | 1.5 | 2.6 |
| 50 and over | 6.7 | 0 | 9.2 | 0 | 0 | 0 | 2.4 | 20.0 |
| All ages together | 32.24 ±.02 | 38.04 ±.14 | 33.38 ±.03 | 40.15 ±.15 | 24.34 ±.06 | 22.93 ±.36 | 28.98 ±.06 | 31.35 ±.23 |

The first thing that strikes the eye from the most cursory inspection of Table 1 is the regularity of the expected decline in the proportion of first births to all births with advancing age of the mothers. Obviously practically all births to mothers aged 10-14 years must, in the nature of things, be first births. But in the next age group, 15-19, the percentage of first births drops to about 80, and in the third age group, 20-24, generally fewer than a half of the women bearing offspring in 1930 were delivering their first product of conception.

The form of the first birth curves by mother's age is shown graphically in Fig. 1, which plots live first birth percentages only.

It is evident from Table 1 and Fig. 1 that the curves for native and foreign-born white mothers are closely similar throughout their

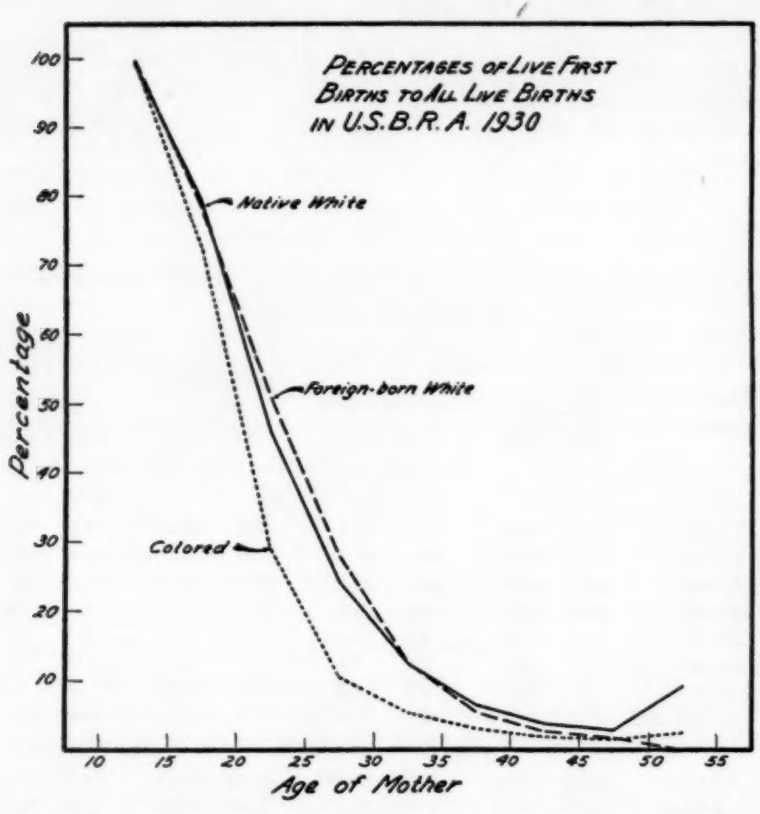


Fig. 1. Percentages of Live First Births According to Age of Mother

extent (except for the 50 and over age groups where the observations are necessarily very meager). It is, however, somewhat unexpected to find at the height of the reproductive period (ages 20-24 and 25-29) that the curve for the foreign-born lies *above* that for the native women, indicating a *higher* proportion of first births. The curve for colored first births (almost entirely Negro of course) differs considerably and systematically throughout its course from both of the white curves. The colored women reproducing in 1930 exhibited generally a smaller proportion of first births than the whites, throughout the age range.

If we consider the proportion of first births to all births for mothers of all ages taken together (bottom line of Table 1) some interesting and significant race(color)-nativity differences appear. In general the native white mothers exhibit a higher total proportion of first births than either the foreign-born whites or the colored mothers, and in turn the foreign-born white mothers a higher proportion than the colored. The differences, with their probable errors, are shown in the following tabular arrangement.

| *Differences in percentages of first births* | | *Diff.* ÷ *P. E. Diff.* |
|---|---|---|
| Native white live minus foreign-born white live | = 9.04±.07 | 129 |
| Native white still minus foreign-born white still | = 17.22±.39 | 44 |
| Native white live minus colored live | = 4.40±.07 | 63 |
| Native white still minus colored still | = 8.80±.28 | 31 |
| Colored live minus foreign-born white live | = 4.64±.09 | 52 |
| Colored still minus foreign-born white still | = 8.42±.43 | 20 |

There can be no doubt about the statistical significance of these differences. They are, in each case, many times larger than could reasonably be expected to arise from errors of sampling. The apparent paradox that while, as is shown clearly in Fig. 1, the curves for native and foreign-born white mothers are rather close together throughout this course, the foreign-born mothers as a whole group have 9 percent fewer live first births than the native mothers, is explained by the differential weighting consequent upon the distorted age distribution of foreign-born white females in 1930 already discussed in an earlier paper.[2]

In each age group, and in each nativity-color class, first stillbirths form a higher percentage of all stillbirths in the class, than do first live births of all live births. This result would reasonably be expected because of the known greater difficulties and hazards of pregnancy and labor in the primipara as compared with the multipara. These reflect themselves in part in the foetal mortality recorded statistically as stillbirths. The differences between the live and stillbirth percentages of first births are generally greatest in the native white mothers and least in the colored mothers, with the foreign-born mothers falling somewhat nearer to the colored in this respect than to the native whites. Paradoxically the percentage of first stillbirths to all stillbirths (for mothers of all ages taken together) in the foreign-born white group is smaller than the percentage of first live births to all live births in the same group (to mothers of all ages taken together), even though in each separate age group the first stillbirth percentage is higher than the corresponding first live birth percentage. This is a consequence of the differential weighting arising from the distorted age distributions of foreign-born white women, of mothers, and especially of mothers producing stillbirths. This distortion of the age distribution of the foreign-born females has already been noted above and in an earlier paper[2], and will become more evident with data presently to be discussed in this paper.

If man as a species operated in his reproduction as do other mammals in a state of nature, uninfluenced by any variables other than the strictly biological ones of innate fertility, unhampered sexual desire, and environmental opportunity, it would be expected that first births would be concentrated in a relatively narrow range of age of mother (or father) following rather closely after the establishment of the physiological capacity to reproduce at or fairly soon after puberty. Actually, from reasons of education, prudence, artificial alterations of the normal functioning of the reproductive mechanism, and various others, the actual reproductive performance of the human species departs widely from the pattern that prevails in lower animals. Just how wide this departure was for the American women reproducing in 1930 is indicated in Tables 2 and 3, and graphically in Fig. 2. The graphs of Fig. 2 are ended in each case a half space beyond the 40-44 years age interval, for the reason that on any scale of feasible plotting the frequencies in the two age classes above 45 years would not be distinguishable in the reproduction.

TABLE 2

*A. Live births. Percentage of births in age class to all births in specified group*

| MOTHER'S AGE (*years*) | NATIVE WHITE | | FOREIGN-BORN WHITE | | COLORED | |
|---|---|---|---|---|---|---|
| | *I para* | *II+ para* | *I para* | *II+ para* | *I para* | *II+ para* |
| 10-14 | 0.2 | 0.0005 | 0.03 | 0 | 2.1 | 0.002 |
| 15-19 | 29.4 | 3.8 | 11.0 | 1.0 | 55.2 | 8.5 |
| 20-24 | 43.2 | 25.4 | 40.5 | 12.5 | 31.8 | 31.4 |
| 25-29 | 18.6 | 29.0 | 31.7 | 26.3 | 7.4 | 26.0 |
| 30-34 | 6.2 | 22.2 | 12.0 | 27.6 | 2.4 | 17.4 |
| 35-39 | 2.0 | 14.3 | 3.9 | 22.8 | .9 | 12.2 |
| 40-44 | .4 | 4.8 | .7 | 8.9 | .2 | 3.8 |
| 45-49 | .02 | .4 | .05 | .9 | .02 | .6 |
| 50 and over | .001 | .007 | 0 | .02 | .001 | .02 |

*B. Percentage of first stillbirths in age class to all stillbirths in all age classes together*

| MOTHER'S AGE (*years*) | NATIVE WHITE | | FOREIGN-BORN WHITE | | COLORED | |
|---|---|---|---|---|---|---|
| | *I para* | *II+ para* | *I para* | *II+ para* | *I para* | *II+ para* |
| 10-14 | 0.3 | 0 | 0 | 0 | 2.3 | 0 |
| 15-19 | 29.1 | 4.0 | 10.6 | 0.8 | 52.3 | 10.4 |
| 20-24 | 39.2 | 19.6 | 31.4 | 7.2 | 31.8 | 29.7 |
| 25-29 | 17.9 | 23.7 | 29.6 | 16.2 | 8.2 | 23.8 |
| 30-34 | 8.3 | 22.4 | 17.5 | 24.6 | 2.9 | 16.7 |
| 35-39 | 3.9 | 20.1 | 8.7 | 31.3 | 1.8 | 13.5 |
| 40-44 | 1.1 | 9.2 | 2.0 | 17.6 | .6 | 4.9 |
| 45-49 | .1 | 1.1 | .3 | 2.3 | .05 | .9 |
| 50 and over | 0 | .004 | 0 | 0 | .02 | .03 |

Consider Table 2 and the first births of Fig. 2. It is at once evident that the colored mothers of 1930 conformed much more closely to the lower animal pattern of first birth distribution by age than did either the native or foreign-born white mothers. The peak of first births in these colored mothers fell in the age period 15-19 years, or, in short, as soon as physiologically possible (on a quinquennial age scale)

TABLE 3

*A. Percentage of live births of all parities in age class to all live births in all classes together*

*B. Percentage of stillbirths of all parities in age class to all stillbirths in all age classes together*

| MOTHER'S AGE (*years*) | NATIVE WHITE | FOREIGN-BORN WHITE | COLORED | NATIVE WHITE | FOREIGN-BORN WHITE | COLORED |
|---|---|---|---|---|---|---|
| 10-14 | 0.1 | 0.007 | 0.6 | 0.1 | 0 | 0.7 |
| 15-19 | 12.4 | 3.4 | 22.1 | 14.1 | 3.0 | 23.6 |
| 20-24 | 31.4 | 19.4 | 31.5 | 27.4 | 12.7 | 30.3 |
| 25-29 | 25.5 | 27.6 | 20.6 | 21.4 | 19.2 | 18.9 |
| 30-34 | 16.9 | 23.8 | 13.0 | 16.7 | 23.0 | 12.4 |
| 35-39 | 10.2 | 18.2 | 9.0 | 13.6 | 26.1 | 9.9 |
| 40-44 | 3.3 | 7.0 | 2.7 | 5.9 | 14.1 | 3.5 |
| 45-49 | .3 | .7 | .4 | .7 | 1.9 | .6 |
| 50 and over | .005 | .01 | .02 | .004 | 0 | .03 |

after puberty. The colored curves then quickly drop so that less than 10 percent of all the first births of the year, either live or still, were produced by mothers in the age class 25-29 years. Furthermore among the colored the live and stillbirth relative frequency curves are very close together throughout their course. In other words, among these colored mothers stillbirths occurred at all ages in a nearly constant proportion to the number of live births at the same ages.

Both the native and foreign-born white women reproducing in 1930 had the peak of their first births in the age period 20-24 years. The live and stillbirth curves in both white groups come down after age 20-24 at a more gradual slope than do those for the colored mothers. There is a characteristic difference in this respect between the live and the stillbirth curves; the latter rise to the peak, and particularly descend from the peak, with a more gradual slope than the former. Generally speaking, the proportion of first stillbirths before mother's age 30 to all first stillbirths tends to be smaller than the proportion of first live births before mother's age 30 to all first live births. This relationship is reversed after age 30. While these relations are true of all the nativity-color groups they are least pronounced in the colored and

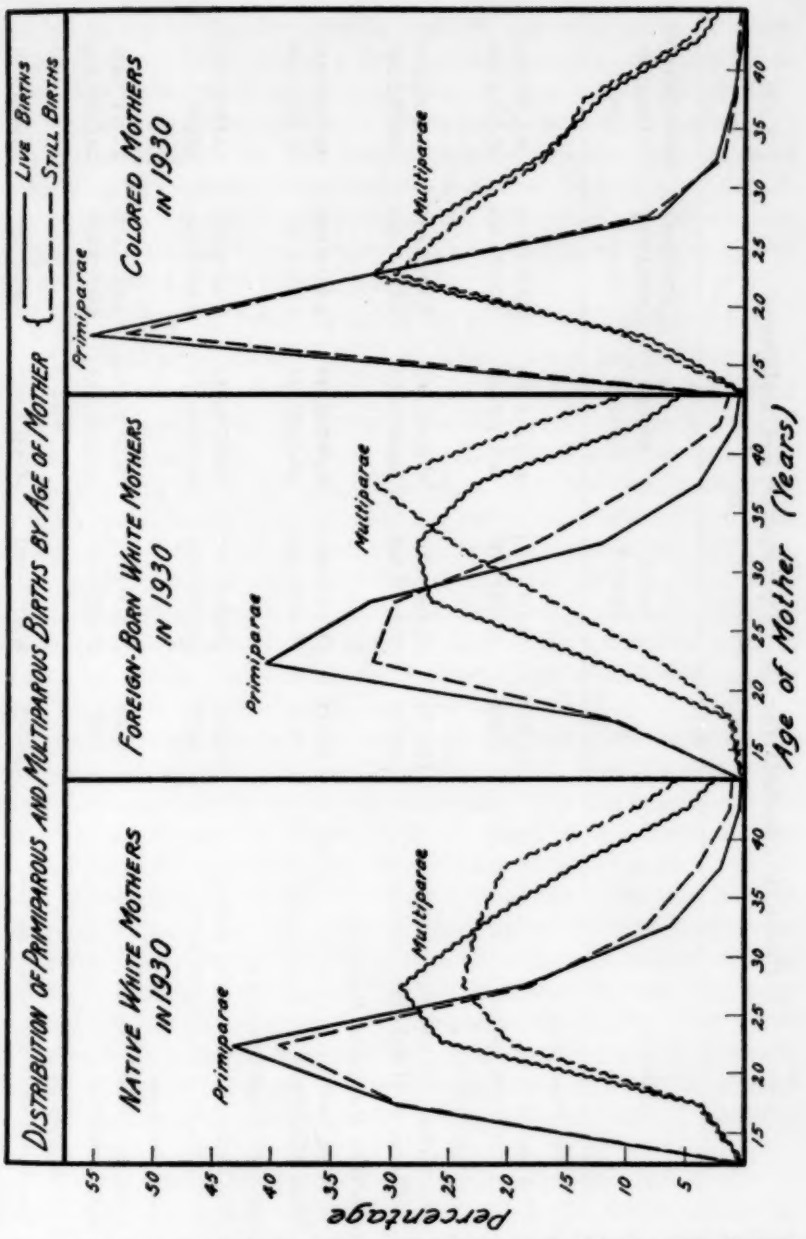


FIG. 2. PERCENTAGE FREQUENCIES OF PRIMIPAROUS AND MULTIPAROUS BIRTHS BY AGE OF MOTHER

TABLE 4

*Biometric constants for age of primiparae and multiparae producing births in 1930*

| GROUP | *N* | MEAN (*years*) | MEDIAN (*years*) | STANDARD DEVIATION (*years*) | COEFFICIENT OF VARIATION (*years*) |
|---|---|---|---|---|---|
| *Native White Primiparae* | | | | | |
| First live births | 527,072 | 22.931±.004 | 22.356±.005 | 4.712±.003 | 20.548±.014 |
| First stillbirths | 18,542 | 23.564±.028 | 22.617±.035 | 5.565±.020 | 23.615±.087 |
| *Native White Multiparae* | | | | | |
| Live births of II and higher parities | 1,051,784 | 29.192±.004 | 28.579±.005 | 6.134±.003 | 21.012±.010 |
| Stillbirths of II and higher parities | 27,639 | 30.859±.028 | 30.626±.035 | 6.816±.020 | 22.088±.066 |
| *Foreign-born Multiparae Multiparae* | | | | | |
| First live births | 56,013 | 25.482±.014 | 24.807±.017 | 4.882±.010 | 19.157±.040 |
| First stillbirths | 1,421 | 26.979±.106 | 26.363±.132 | 5.899±.074 | 21.866±.290 |
| *Foreign-born White Multiparae* | | | | | |
| Live births of II and higher parities | 174,090 | 31.963±.010 | 31.857±.012 | 5.971±.007 | 18.681±.022 |
| Stillbirths of II and higher parities | 4,777 | 34.528±.060 | 35.199±,075 | 6.128±.042 | 17.748±.126 |
| Colored Primiparae | | | | | |
| First live births | 71,929 | 20.311±.011 | 19.336±.013 | 4.269±.008 | 21.021±.039 |
| First stillbirths | 5,681 | 20.753±.042 | 19.554±.053 | 4.696±.030 | 22.630±.150 |
| *Colored Multiparae* | | | | | |
| Live births of II and higher parities | 176,283 | 27.857±.010 | 26.933±.013 | 6.460±.007 | 23.189±.028 |
| Stillbirths of II and higher parities | 12,438 | 28.092±.042 | 27.084±.053 | 6.927±.030 | 24.658±.112 |

most so in the foreign-born white, with the native white in an intermediate position. The risk of a first pregnancy ending with a stillbirth rather than a live birth appears, in short, to increase as the women's first pregnancy is postponed later and later in her fecund period.

The relationships of first births under discussion may be more precisely comprehended quantitatively from the figures of Table 4. Therein are given the biometric constants for age of women-mothers in 1930, separated into two groups; *viz.* (a) primiparae (parity I) and (b) multiparae (II and higher parities).

From Table 4 the following points are particularly worthy of note:

1. One half of all the colored women who had first live births in 1930 were *under* 19 and a third years of age. One half of all the native white women producing live births in the same year were *under* 22 and a third years of age. This is a significantly higher median age (by 3.020±.014 years) but still absolutely a fairly low one, considering the white *mores* in this country relative to education, marriage, etc. The median age of the foreign-born white mothers producing first live births in 1930 was considerably higher than in either of the other two nativity-color groups. Half the foreign-born primiparae (bearing live offspring) were *over* 24.8 years of age. This reflects the relative scarcity of young females in the distorted age distribution of the foreign-born, to which allusion has been made above.

2. In all three race(color)-nativity groups the mean ages of the primiparae of 1930 are *higher* than the median ages, by small but nevertheless statistically significant amounts. The differences are an index of the degree of skewness—in all cases in the same positive direction—exhibited in the age distributions of primiparae.

3. In all three race(color)-nativity groups the mean and median ages of primiparae bearing stillborn offspring as the first product of their reproductive efforts are *higher* than the mean and median ages of primiparae bearing live babies. These differences are not very large absolutely, but without exception statistically significant. The result is presumably a biometric reflection of the well-known fact that generally speaking the older a woman is when she starts reproducing the greater the difficulties she encounters in her first pregnancy and its resulting labor.

4. The variation in age of women producing their first births, as measured by the standard deviation (which on the whole seems the fairest index of relative as well as absolute variability for the present

| | | | | | | |
|---|---|---|---|---|---|---|
| Live births of II and higher parities..... | 170,283 | 27.857±.010 | 26.933±.013 | 6.460±.007 | 23.189±.028 |
| Stillbirths of II and higher parities..... | 12,438 | 28.092±.042 | 27.084±.053 | 6.927±.030 | 24.658±.112 |

material and *Fragestellung*) is greatest in the foreign-born white group, less in the native white group, and least in the colored group. Tested by this criterion the native white women are farthest removed from the normal lower mammal pattern of reproductivity relative to age, while the colored women are significantly nearer to it, the difference being 0.443 ± .009 years for live first births, and 0.869 ±.010 years for first stillbirths.

5. In all three race(color)-nativity groups the women producing first stillbirths are significantly more variable in age than the women producing first live births.

6. One half of all the colored women who produced their second or higher order live births in 1930 were *over* 27 years (approximately) of age, while one half of the similarly parous native white women were over 29 years of age. The corresponding figure for the corresponding foreign-born white women was approximately 32 years. The spread between the median ages of primiparae and multiparae, as groups, was, in other words from 6.223±.007 years in the case of the native white women, through 7.050±.021 years in the foreign-born white women, to 7.597±.018 years in the colored women, so far as concerns live births only. For stillbirths the figures would be substantially the same. These spreads reflect the comparative group extension of actual expressed reproductivity into the higher ages as the menopause is approached, or equally, in an inverse sense, the comparative failure of such higher age reproductivity. This point, however, can be more effectively discussed later in the paper when other data are at hand.

7. In respect of relationship between (a) mean and median ages and (b) ages of mothers of live and stillbirths the multiparae conform to the same general pattern as the primiparae.

8. While the colored primiparae are the *least* variable in age (as judged by the standard deviation) of any of the race(color)-nativity groups, the colored multiparae are the *most* variable, conforming from another angle the conclusion reached above that this colored group approaches most closely of the three to the lower mammal reproductivity pattern.

9. The mean age is higher, and the variation is greater, in multiparae producing stillbirths than in multiparae producing live births just as was found to be the case for primiparae.

Table 2 and Fig. 2 should be examined in connection with Table 3. While the former give the relative frequency distributions for first births and multiparous births, the latter gives the corresponding distributions of all births of all parities by age of mother. It is at once as obvious as it is statistically necessary that the scatter of mother's ages is greater for all births of all parities than it is for first births. Other striking differences between the distributions are to be noted. For the native white mothers the peak of both the live and stillbirth distributions remains in the same age class (20-24) for all births that it had for first births. In the case of the foreign-born white and the colored mothers it moves up one class for all live births (to 25-29 and 20-24 respectively) above its position for first births only.

In the colored the all-birth-all-parity relative frequency distributions of live and stillbirths still fall very close to each other, as was the case for the first birth distributions. But in the case of foreign-born mothers the all-stillbirth-all-parity distribution diverges widely from the corresponding live birth distribution. Its peak is found in the 35-39 year age class—ten years higher than the live birth peak, and 15 years higher than the peak for first stillbirths to foreign-born white mothers, as shown in Fig. 2. Over 42 percent of all stillbirths to foreign-born white women in 1930 were borne by women falling in age between 35 years and the menopause. In contrast to this only a trifle over 14 percent of the stillbirths to colored mothers occurred in women of these ages, and only about 20 percent to native white women of corresponding ages. The older foreign-born white mothers quite plainly experienced an undue proportion of difficult labors or diseases of the reproductive organs leading to stillbirths, or both. On all the evidence available it is to be supposed that the venereal diseases *sensu stricto* (syphilis and gonorrhea) are much more prevalent in the colored women than in the whites of either native or foreign birth, and syphilis certainly is a major cause of abortion and stillbirth. The figures of Table 3, however, run rather definitely contrary to any interpretation along this line. A further complication is seen in the fact that while over 42 percent of the stillbirths to foreign-born white women are from mothers 35 years of age and over, the corresponding percentage of all live births is only about 26. There are evidently special factors, not apparent from the available data, operating to produce an excessive foetal mortality in the foreign-born white mothers.

TABLE 5

*Biometric constants for age of mothers of all births of all parities in 1930*

| CONSTANTS FOR MOTHER'S AGE | NATIVE WHITE | | FOREIGN-BORN WHITE | | COLORED | |
|---|---|---|---|---|---|---|
| | All live births | All stillbirths | All live births | All stillbirths | All live births | All stillbirths |
| Mean (*years*) ..... | 27.102±.003 | 27.930±.023 | 30.385±.009 | 32.798±.059 | 25.670±.009 | 25.791±.036 |
| Median (*years*) ..... | 26.211±.004 | 26.951±.029 | 29.934±.011 | 33.262±.074 | 24.334±.012 | 24.239±.045 |
| St. Dev. (*years*) ..... | 6.418±.002 | 7.282±.016 | 6.365±.006 | 6.855±.042 | 6.785±.006 | 7.172±.025 |
| C. of V. (percent) ..... | 23.682±.009 | 26.072±.062 | 20.947±.022 | 20.901±.132 | 26.431±.027 | 27.810±.106 |

The biometric constants for the distributions of all births of all parities relative to age of mother are shown in Table 5.

### III. PATTERNS OF REPRODUCTIVITY COMPARED

It has been pointed out above that according to the normal pattern of reproduction among the mammals lower than man it would be expected that the mean age of mothers of first births would be only a little above the mean age at puberty or menarche (taken as the beginning of the physiological possibility of reproducing by the female). Further it would be expected that the amount of variation in mother's age at first birth would, on the lower animal pattern, be small. Let us now examine into the question of the degree of departure quantitatively of the present-day human pattern or reproduction from this more primitive mammalian pattern. To facilitate this Table 5 is presented. It gives the basic biometric constants, calculated in this laboratory by standard and uniform methods, for 32 frequency distributions of age at menarche taken from the literature, and believed to be carefully and accurately recorded. The different groups, each represented by a separate distribution and set of constants, are arranged in Table 6 in descending order of the values of the mean ages at menarche.

Table 6 covers within its bounds practically the whole range of group *mean* values for age at menarche that have ever been observed or recorded, as may be seen by comparison with Frommolt's[4] recent extensive compilation of data on the point, or with the present writer's[5] more critical condensation of Frommolt's tables. Now the unweighted averages of the mean and median ages at menarche given in Table 6 are respectively:

Unweighted average of means = 15.18 years
Unweighted average of medians = 15.09 years

From these figures, as well as from the individual items of Table 6, it is apparent that the distribution of variation in age at menarche is in general symmetrical with no significant skewness. Furthermore it is evident that no serious error will be made in taking 15 years in

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[4]Frommolt, G. Rassefragen in der Geburtshilfe und Gynäkologie. *Leipzig* (J. A. Barth), 1936. Pp. [6] + 96.

[5]Pearl, R. Biological factors in fertility. *Annals of the Amer. Acad. Pol. and Soc. Sci.*, Vol. 188, pp. 14-25, 1936.

## TABLE 6

*Biometric constants for age at menarche*

| GROUP | *N* | MEAN (*years*) | MEDIAN (*years*) | STANDARD DEVIATION (*years*) | COEFFICIENT OF VARIATION (*percent*) | RANGE (*years*) | SOURCE OF DATA |
|---|---|---|---|---|---|---|---|
| German (Rural, "Kassen") ..... | 68 | 16.84±.16 | 16.75±.20 | 1.97±.11 | 11.69± .69 | 12-20 | Heyn, 1920 |
| German (Total cases) ..... | 8881 | 16.57±.02 | 16.46±.02 | 2.13±.01 | 12.87± .07 | 9-27 | Schlichting, 1880 |
| German (München) ..... | 1641 | 16.37±.04 | 16.23±.05 | 2.17±.03 | 13.28± .16 | 10-24 | Schlichting, 1880 |
| German (Urban, "Kassen") ..... | 623 | 16.21±.05 | 16.18±.07 | 2.02±.04 | 12.43± .24 | 11-22 | Heyn, 1920 |
| Czechoslovakian (Rural) ..... | 234 | 16.14±.09 | 15.97±.11 | 2.01±.06 | 12.48± .40 | 11-24 | Baroch, 1929 |
| German (Rural, private)..... | 497 | 15.97±.06 | 15.82±.08 | 2.04±.04 | 12.75± .28 | 11-24 | Heyn, 1920 |
| Brazilian (Sao Paulo, born in Lithuania) | 68 | 15.85±.16 | 15.75±.21 | 2.01±.12 | 12.71± .75 | 12-20 | Mattos, 1934 |
| German (Urban, private) ..... | 2082 | 15.75±.03 | 15.65±.04 | 2.02±.02 | 12.83± .14 | 10-26 | Heyn, 1920 |
| Czechoslovakian (Prague) ..... | 181 | 15.75±.11 | 15.38±.14 | 2.27±.08 | 14.40± .52 | 10-24 | Baroch, 1929 |
| English (Manchester) ..... | 450 | 15.70±.06 | 15.60±.07 | 1.87±.04 | 11.92± .27 | 11-20 | McLaury, 1887 |
| Brazilian (Sao Paulo, born in Poland) ... | 43 | 15.69±.22 | 15.31±.28 | 2.17±.16 | 13.85±1.03 | 10-21 | Mattos, 1934 |
| Brazilian (Sao Paulo, born in Hungary).. | 74 | 15.39±.14 | 15.50±.17 | 1.76±.10 | 11.43± .64 | 11-20 | Mattos, 1934 |
| Italian ..... | 261 | 15.37±.08 | 14.73±.10 | 1.84±.05 | 11.99± .36 | 10-21 | Marro, 1901 |

TABLE 6 (*Cont.*)

*Biometric constants for age at menarche*

| GROUP | *N* | MEAN (*years*) | MEDIAN (*years*) | STANDARD DEVIATION (*years*) | COEFFICIENT OF VARIATION (*percent*) | RANGE (*years*) | SOURCE OF DATA |
|---|---|---|---|---|---|---|---|
| Brazilian (Sao Paulo, born in Russia).... | 81 | 15.31±.16 | 15.23±.20 | 2.11±.11 | 13.76± .74 | 11-20 | Mattos, 1934 |
| Chinese (Canton, Rural) ..... | 1422 | 15.28±.04 | 15.35±.05 | 2.19±.03 | 14.31± .19 | 10-26 | Chau and Wright, 1925 |
| Brazilian (Sao Paulo, born in Germany).. | 155 | 15.17±.09 | 15.10±.12 | 1.74±.07 | 11.47± .45 | 10-19 | Mattos, 1934 |
| Brazilian (Sao Paulo, born in Portugal)... | 511 | 15.05±.06 | 14.87±.07 | 1.97±.04 | 13.06± .28 | 10-21 | Mattos, 1934 |
| Chinese (Canton. Total group)... | 2291 | 15.02±.03 | 15.15±.04 | 2.16±.02 | 14.41± .15 | 9-26 | Chau and Wright, 1925 |
| American (Urban, irregular type).. | 584 | 14.76±.05 | 14.53±.07 | 1.90±.04 | 12.88± .26 | 9-22 | Sanes, 1916 |
| Brazilian (Sao Paulo, born in Argentina) | 22 | 14.73±.32 | 15.00±.40 | 2.22±.23 | 15.05±1.56 | 11-19 | Mattos, 1934 |
| Brazilian (Sao Paulo, born in Italy)..... | 669 | 14.70±.05 | 14.51±.06 | 1.82±.03 | 12.38± .23 | 10-24 | Mattos, 1934 |
| Brazilian (Sao Paulo, born in Syria)..... | 32 | 14.66±.16 | 14.63±.20 | 1.32±.11 | 8.99± .76 | 12-18 | Mattos, 1934 |

TABLE 6 (*Cont.*)

*Biometric constants for age at menarche*

| GROUP | *N* | MEAN (*years*) | MEDIAN (*years*) | STANDARD DEVIATION (*years*) | COEFFICIENT OF VARIATION (*percent*) | RANGE (*years*) | SOURCE OF DATA |
|---|---|---|---|---|---|---|---|
| Brazilian (Sao Paulo, born in Spain)..... | 406 | 14.61±.06 | 14.47±.08 | 1.81±.04 | 12.42± .30 | 10-20 | Mattos, 1934 |
| Chinese (Canton, urban)..... | 869 | 14.59±.05 | 14.73±.06 | 2.05±.03 | 14.08± .23 | 9-25 | Chau and Wright, 1925 |
| American (Urban, all cases)..... | 2864 | 14.58±.02 | 14.40±.03 | 1.70±.02 | 11.69± .11 | 9-24 | Sanes, 1916 |
| American (Urban, regular type)... | 2280 | 14.53±.02 | 14.38±.03 | 1.65±.02 | 11.33± .11 | 9-24 | Sanes, 1916 |
| Brazilian (Sao Paulo, totals)..... | 7210 | 14.55±.01 | 14.42±.02 | 1.75±.01 | 12.02± .07 | 6-27 | Mattos, 1934 |
| German (Berlin primiparae under 20)... | 1426 | 14.46±.02 | 14.46±.03 | 1.31±.02 | 9.06± .12 | 10-18 | Mikulicz-Radecki and Kausch, 1935 |
| Brazilian (Sao Paulo, born in Brazil).... | 5043 | 14.39±.02 | 14.32±.02 | 1.65±.01 | 11.47± .08 | 6-27 | Mattos, 1934 |
| Japanese (Osaka Medical School).. | 373 | 14.25±.04 | 14.24±.05 | 1.23±.03 | 8.64± .21 | 9-20 | Kosakae *et al.*, 1933 |
| Korean ..... | 424 | 14.01±.04 | 14.04±.04 | 1.15±.03 | 8.24± .19 | 10-18 | Lee, 1930 |
| Chinese (Shanghai and Wuchung)..... | 309 | 13.56±.06 | 13.60±.07 | 1.35±.04 | 9.99± .27 | 10-16 | Westbrook *et al.*, 1934 |

References to sources of original data from which the constants in Table 6 were computed:

Baroch, F. Doba menopausy u českých žen a jejich plodnost. *Anthropologie, Praha,* Vol. 7, pp. 282-298, 1929.

Chau, K. T., and J. M. Wright. Gynecological notes, Canton Hospital. *China Med. Jour.,* Vol. 39, pp. 684-687, 1925.

Heyn, A. Ueber Menstruation, Haarfarbung und Libido und ihre gegenseitigen Beziehungen. *Zeitschr. f. Geburtsh. u. Gyn.,* Bd. 82, pp. 136-152, 1920.

Kosakae, J., K. Kawanabe, Y. Kuraishi, and A. Yamamura. Beiträge zur Statistik über die Menstruation der japanischen Studentin. *Japanese Jour. of Obst. and Gyn.,* Vol. 16, pp. 141-162, 1933.

Lee, Y. C. The first menses of Korean girl students. *China Med. Jour.,* Vol. 44, pp. 31-37, 1930.

Marro, A. La Puberté chez l'Homme et chez la Femme. Traduit sur la deuxième edit. italien par J. P. Medici. *Paris* (Lib. C. Reinwald-Schleicher Frères) 1901. Pp. xvi + 536.

Mattos, S. O. Menarca. Contribuição para o seu estudo São Paulo. *Annaes Paulistas de Med. e Cir.,* T. 28, pp. 5-12; 111-126, 1934.

McLaury, W. M. Remarks on the relation of menstruation to the sexual function. *Amer. Jour. Obst.,* Vol. 20, pp. 158-164, 1887.

Mikulicz-Radecki, F. v., and Eva Kausch. Beziehungen zwischen Kohabitation und Gravidität in jugendlichem Alter und der daraus erkannte physiologische Follikelzyklus beim Mädchen. *Zentralbl. f. Gyn.,* Bd. 59, pp. 2290-2302, 1935.

Sanes, K. I. Menstrual statistics: a study based on 4500 menstrual histories. *Amer. Jour. Obst.,* Vol. 73, pp. 93-112, 1916.

Schlichting, F. X. Statistisches über den Eintritt der ersten Menstruation und über Schwangerschaftsdauer. *Arch. f. Gynäk.,* Bd. 16, pp. 203-232, 1880.

Westbrook, C. H., D. G. Lai, and S. D. Hsiao. Some physical aspects of adolescence in Chinese students. *Chinese Med. Jour.,* Vol. 48, pp. 37-46, 1934.

round figures as the average age at which reproduction in the human female becomes physiologically possible, in theory at least.

By reference back to Table 4, it becomes possible to form the following set of differences between average age at menarche, on the one hand, and average age of American mothers of 1930 producing their first child.

| | *Differences in years* | |
|---|---|---|
| *Group* | *First live births* | *First stillbirths* |
| Native white | 7.75 | 8.38 |
| Foreign-born white | 10.30 | 11.80 |
| Colored | 5.13 | 5.57 |

Now the unweighted average of the four critically trustworthy means for total duration of menstrual life (menarche to menopause) that I have so far been able to collect is (see Table 7, *infra*) 32.44 years.

So then it appears that, *on the average*, the present day pattern of human reproduction, as exemplified by American women who bore children in 1930, exhibits the following percentages of the total reproductive life span spent in the period between menarche and the bearing of the first child.

| | *Percentages* | |
|---|---|---|
| *Group* | *First live births* | *First stillbirths* |
| Native white | 23.9 | 25.8 |
| Foreign-born white | 31.8 | 36.4 |
| Colored | 15.8 | 17.2 |

In other words it appears that, as American women currently practice reproduction, from roughly 16 to 36 percent of their total reproductive span elapses, as an average figure, between the time they become physiologically capable of reproducing and the time when their first product of conception appears upon the scene. While this statement is confined to American women, as is proper since the data presented are thus restricted, nevertheless it is quite certain on general grounds that other populations at similar cultural and economic levels would show the same general sort of results as to the time lag in beginning reproduction. Some countries would at the present time show an even greater lag than the United States. This delay in getting started at reproduction in itself accounts in no negligible degree for the fact that in general human beings are relatively poor breeders.

The reproductive pattern may next be examined from its variation aspect. If women followed closely the lower animal pattern it is clear that the variation in age of mothers at the birth of their first babies should be of nearly the same order of magnitude as their variation in age at menarche.

Now the unweighted average of the standard deviations for age at menarche set forth in Table 6 is 1.85 years. By the use of this figure and the standard deviation in age at first birth given in Table 4 there can be set up the following system of differences between variation in age at menarche and in age at first birth, the degree of variation in both cases being measured by the standard deviation.

| | *Differences in variation (years)* | |
|---|---|---|
| *Group* | *First live births* | *First stillbirths* |
| Native white | 2.86 | 3.72 |
| Foreign-born white | 3.03 | 4.05 |
| Colored | 2.42 | 2.85 |

These figures indicate that the American primiparae of 1930 exhibited on the average much greater variability in age at their first births than the general average variation recorded for age at menarche. In this respect the colored primiparae, as before, came nearest—though still a long way off from—the primitive animal pattern of reproductivity.

How great these differences in variability are relatively may be shown by translating them into percentages as follows:

| | *Percentage Differences* | |
|---|---|---|
| *Group* | *First live births* | *First stillbirths* |
| Native white | 154.6 | 201.1 |
| Foreign-born white | 163.8 | 218.9 |
| Colored | 130.8 | 154.1 |

Thus it is seen the present practice of American women in reproduction leads to a variation in age at first birth that is from 131 to 219 percent greater than the general average variation in age at menarche.

Table 7 gives the biometric constants for total duration of reproductive life in four series of women—all that I have collected from the literature up to the time of writing. In all these series the total duration of reproductive life in an individual woman is taken to be

TABLE 7

*Biometric constants for length of menstrual life*

| GROUP | *N* | MEAN (*years*) | MEDIAN (*years*) | STANDARD DEVIATION (*years*) | COEFFICIENT OF VARIATION (*percent*) | RANGE (*years*) | SOURCE OF DATA |
|---|---|---|---|---|---|---|---|
| Czechoslovakian (Urban) ..... | 189 | 33.05±.22 | 33.30±.27 | 4.45±.15 | 13.47±.48 | 20-46 | Baroch, 1929 |
| Czechoslovakian (Rural) ..... | 237 | 32.76±.20 | 33.27±.25 | 4.64±.14 | 14.17±.45 | 19-48 | Baroch, 1929 |
| American (Urban) ..... | 178 | 32.39±.27 | 33.29±.34 | 5.42±.19 | 16.74±.62 | 14-42 | Sanes, 1916 |
| German (Reichenbach) ..... | 188 | 31.54±.22 | 32.50±.27 | 4.44±.15 | 14.08±.50 | 15-41 | Heyn, 1920 |

the same as duration of her menstrual life—the difference in years between her ages at menarche and menopause respectively. The data in the table are arranged in descending order of mean values.

Table 7 is striking in its regularity and slight inter-group diversity. One concludes from it with considerable confidence that, on the average, the human female is theoretically capable of reproduction over a span of about 32 years. This figure gives an interesting indication of how closely the rare women who produce in their reproductive life times 24 to 29 or so births approach to the physiologically possible limit. A few such women appear in each annual report on birth statistics.

On the primitive animal pattern of reproductivity it is clear that, except for the influence of a true physiological decline in innate fecundity and fertility with advancing age, the variation in age of women at births of all parities taken together should be of generally the same order of magnitude as variation in total duration of menstrual life. By taking the unweighted average of the standard deviations of Table 7 it appears that this latter value is represented by a scatter of 4.74 years.

A comparison of this figure with the standard deviations of Table 5 leads to the following system of differences between the variability in duration of reproductive life, on the one hand, and in age of mothers of all parities producing offspring in a particular year, on the other hand.

| | *Differences in variation (years)* | |
|---|---|---|
| *Group* | *Live births* | *Stillbirths* |
| Native white | 1.68 | 2.54 |
| Foreign-born white | 1.63 | 2.12 |
| Colored | 2.05 | 2.43 |

It thus appears that the women bearing offspring in 1930 were considerably more variable in age at the time of the event than women in general are in respect of duration of their total reproductive life span. It seems reasonable to suppose that whatever progressive diminution in innate fecundity and fertility with advancing age there may be, would have the tendency to *reduce* the variability in age exhibited by women of all parities bearing children in a particular year (because it would tend to relative under-representation of higher as compared with lower ages). If this is so the differences shown above need no correction on account of this factor, because as they stand they repre-

sent at least minimal departures from the primitive animal reproductivity pattern. How great these departures are relatively is shown by the following percentages:

| | *Percentage Differences* | |
|---|---|---|
| *Group* | *Live births* | *Stillbirths* |
| Native white | 35.4 | 53.6 |
| Foreign-born white | 34.4 | 44.7 |
| Colored | 43.2 | 51.3 |

So then it appears that the women bearing children in 1930 were from 34 to 54 percent more variable in age than women in general are in respect of the total duration of the physiologically possible reproductive span. These are not as large departures from the primitive animal reproductivity pattern as those exhibited by the primiparae, but still considerable.

To summarize briefly the discussion in this section it may be said that the women in the U. S. Birth Registration Area bearing children in 1930 showed a pattern of reproductivity widely divergent from that exhibited by mammals lower in the evolutionary scale, in all respects tested. The divergences were greatest in the performance of primiparae. Among the nativity-race(color) groups the colored came closest to the animal pattern, so far as concerns primiparae, and on the whole farthest from it in the one respect in which the behavior of women of all parities were tested. Further light on the latter point will appear in a later section.

### IV. ADEQUATE REPRODUCTIVITY

Up to this point the discussion has been centered chiefly about primiparae, with women of other parities brought in for purpose of comparison. It has been shown that from roughly 23 to 40 percent of the women bearing products of conception in 1930 were primiparae, an obviously high proportion when viewed from the angles of race survival and population growth. These figures take on a still more ominous cast when it is remembered that a definite though not now precisely ascertainable proportion of these primiparae will never bear any more children. It is evident that unless a woman produces more than one child in her life time she is not adequately reproducing even herself, to say nothing of her family (self and consort) or her strain.

Many years ago in discussing reproduction and survival in the domestic fowl the present writer[6] pointed out the necessity of considering mortality before reproductive life began in appraising net adequate reproductivity, and developed a survival index number for the quantification of such appraisal. In recent years this general concept of net effective reproductivity has been applied by various students to the human situation. Notably Dublin and Lotka[7] have developed this field extensively and accurately. One of their conclusions was that for the population constituted as it was in 1920 and with prevailing mortality rates, there would be required 3.15 children per fertile married female just to maintain the population at a stationary level.

On this and other general grounds it seems a fair postulate to say that if, in a given year, a women produces her *fourth* living child, she may be regarded as having adequately reproduced. On the basis of this postulate we may proceed now to examine the question as to what proportion of the women of different ages reproducing in 1930 had, with their performance of that year, completed the demonstration of adequate reproductivity as postulated.

As the first step Table 8 is presented. The coverage of this table is clearly stated in its caption.

If the figures of Table 8 give, as they do, the percentages of women who in 1930 bore their first, second, or third live birth, it follows that the differences, cell for cell, between the percentages set forth in Table 8 and 100 will give the percentages of all women overtly fertile in 1930 who in that year produced either their fourth living birth, or a living birth of higher parity order. In short, proceeding in this way, Table 9 exhibits the proportion of women who had completed the demonstration of their adequate reproductivity.

From the totals of Table 9 it appears that in round figures about 29 percent of all the native white women reproducing in 1930 were having their fourth or higher order birth, counting live births only in both cases, while about 40 percent each of the corresponding foreign-born and colored women were in the same position. In other words,

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[6]Pearl, R. Studies on the physiology of reproduction in the domestic fowl. XVII. The influence of age upon reproductive ability, with a description of a new reproductive index. *Genetics,* Vol. 2, pp. 417-432, 1927.

[7]Dublin, L. I., and A. J. Lotka. On the true rate of natural increase as exemplified by the population of the United States, 1920. *Jour. Amer. Stat. Assoc.* Vol. 20, pp. 305-339, 1925. This pioneer paper has been followed by others by the same authors, jointly and separately, that should be consulted.

## TABLE 8

*Percentages of all live births in 1930 (of recorded mother's age and parity) that were either first, second, or third births*

| MOTHER'S AGE (*years*) | TOTAL WHITE | NATIVE WHITE | FOREIGN-BORN WHITE | COLORED |
|---|---|---|---|---|
| 10-14 | 100 | 100 | 100 | 100 |
| 15-19 | 0.4 | 0.4 | 0.7 | 1.2 |
| 20-24 | 92.1 | 92.1 | 92.0 | 79.1 |
| 25-29 | 70.9 | 70.2 | 75.4 | 40.6 |
| 30-34 | 48.0 | 47.5 | 50.7 | 21.0 |
| 35-39 | 27.8 | 28.4 | 25.6 | 11.6 |
| 40-44 | 15.1 | 15.9 | 12.5 | 6.7 |
| 45-49 | 9.0 | 9.4 | 7.8 | 5.5 |
| 50 and over | 20.2 | 23.7 | 10.7 | 14.6 |
| All ages together | 69.26 | 70.67 | 59.65 | 59.74 |

## TABLE 9

*Percentages of all live births in 1930 (of recorded mother's age and parity) that were fourth births or of higher order of parity*

| MOTHER'S AGE (*years*) | TOTAL WHITE | NATIVE WHITE | FOREIGN-BORN WHITE | COLORED |
|---|---|---|---|---|
| 10-14 | 0 | 0 | 0 | 0 |
| 15-19 | 0.4 | 0.4 | 0.7 | 1.2 |
| 20-24 | 7.9 | 7.9 | 8.0 | 20.9 |
| 25-29 | 29.1 | 29.8 | 24.6 | 59.4 |
| 30-34 | 52.0 | 52.5 | 49.3 | 79.0 |
| 35-39 | 72.2 | 71.6 | 74.4 | 88.4 |
| 40-44 | 84.9 | 84.1 | 87.5 | 93.3 |
| 45-49 | 91.0 | 90.6 | 92.2 | 94.5 |
| 50 and over | 79.8 | 76.3 | 89.3 | 85.4 |
| All ages together | 30.74 ± .02 | 29.33 ± .02 | 40.35 ± .07 | 40.26 ± .07 |

over a tenth part more of the women in their respective classes had attained adequate reproductivity among the foreign-born white and the colored groups than was the case among the native-born whites. Put in another way, it may be seen by comparing the "all ages together" percentages of Table 1 and 9 that whereas the native white women producing live births in 1930 had 4.05 percent *fewer* fourth and higher parity births than they did first births, the foreign-born white had 16.01 percent *more* fourth and higher parity births than first births, and the colored had 11.28 percent more fourth and higher parity births than single births. The moral of these figures from the population view point,

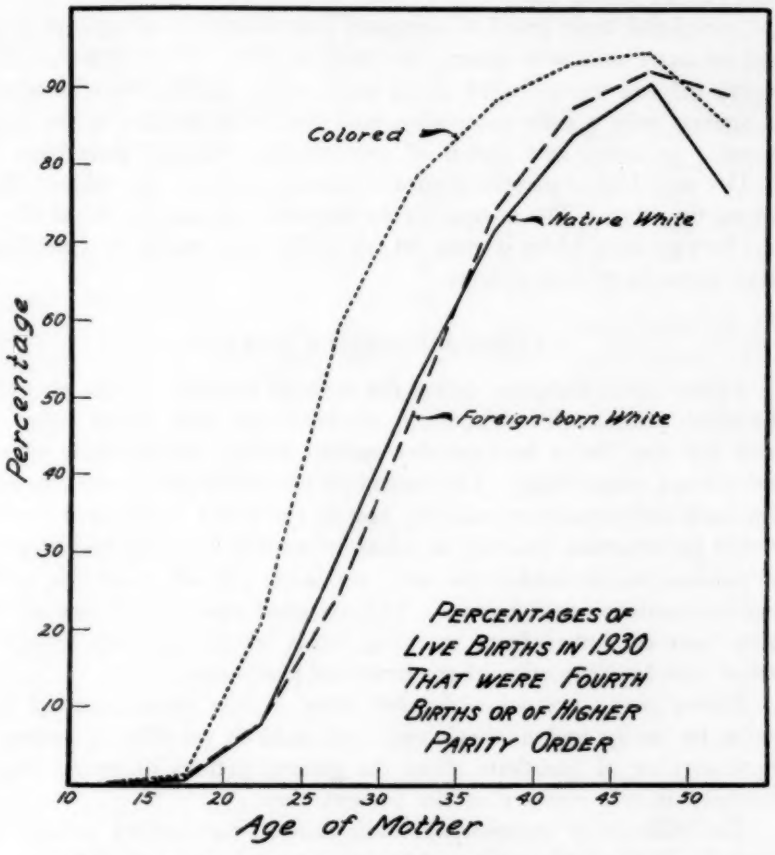


FIG. 3. AGE DISTRIBUTION OF ADEQUATE REPRODUCTIVITY 1930

both as to quantity (survival) and as to what the eugenist is pleased to regard as "quality" composition, is evident without further elaboration.

The age differentials in respect of adequate reproductivity are interesting. To make the facts more apparent Figure 3, plotted from the data of Table 9 is presented.

The most striking thing about the age distribution of adequate reproductivity is the marked contrast between the white and the colored women. While only just under 8 percent of the former in the age group 20-24 years were having their fourth or higher parity live birth nearly 21 percent of the latter were so doing. In the next higher age class (25-29 years) just slightly under 60 percent of the colored women had completed their proof of adequate reproductivity, as against about half as many relatively among the white women. Over three-quarters of the colored women aged 30-34 years were quadriparous or better, as against only a little more than half the white women in the same period. In every age period of reproductive life the percentage of of IV- and higher-parous women is greater among the colored than among the white. The adequate reproductivity age curves of the native and foreign-born white women do not differ very markedly from each other throughout their courses.

### V. PARITY-AGE CONTOUR SURFACES

Tables 10-12 inclusive define the contour surfaces of the observed statistical probabilities relative to mother's age and parity order of birth for live births in 1930, for native whites, foreign-born whites, and colored respectively. The entries in the tables are chances in 100, and each table therefore sums to 100 in the lower right hand corner. It will be seen that in order to avoid numerical pedantry and expense of publication, decimals have been ruthlessly cut off, with the result that summations are not exact. The marginal column and row entries have been computed from marginal totals of the absolute numbers, rather than by summation of the inner cell percentages.

Tables 10-12 present a detailed view of the distribution of live births by parity and mother's age, and make it possible to answer a great number of questions about the general pattern of group reproductivity in this country at the present time.

The differences between the three nativity-race(color) groups are marked. While in the native white group 12.4 percent of all live births

## TABLE 10

*Contour surface for live births of 1930 to native white mothers, by age and parity. Entries are chances in 100*

| PARITY ORDER OF BIRTH | MOTHER'S AGE (*years*) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10-14 | 15-19 | 20-24 | 25-29 | 30-34 | 35-39 | 40-44 | 45-49 | 50 and over | All ages together |
| 1 | 0.08 | 9.8 | 14.4 | 6.2 | 2.1 | 0.7 | 0.1 | 0.008 | 0.0004 | 33.38 |
| 2 | .0003 | 2.2 | 9.8 | 6.7 | 3.0 | 1.0 | .2 | .008 | .0003 | 22.88 |
| 3 | .... | .3 | 4.7 | 5.0 | 2.9 | 1.2 | .2 | .01 | .0004 | 14.40 |
| 4 | .... | .04 | 1.8 | 3.5 | 2.5 | 1.3 | .3 | .01 | .0003 | 9.40 |
| 5 | .... | .007 | .5 | 2.2 | 2.1 | 1.2 | .3 | .02 | .0006 | 6.36 |
| 6 | .... | .002 | .1 | 1.1 | 1.7 | 1.1 | .3 | .02 | .0004 | 4.46 |
| 7 | .... | .... | .03 | .5 | 1.2 | 1.1 | .3 | .02 | .0003 | 3.10 |
| 8 | .... | .... | .01 | .2 | .7 | .9 | .3 | .03 | .0004 | 2.19 |
| 9 | .... | .... | .004 | .05 | .4 | .7 | .3 | .03 | .0005 | 1.48 |
| 10 | .... | .... | .002 | .02 | .2 | .5 | .3 | .03 | .0004 | .99 |
| 11 | .... | .... | .002 | .008 | .07 | .3 | .2 | .03 | .0003 | .60 |
| 12 | .... | .... | .... | .003 | .03 | .1 | .2 | .02 | .0001 | .36 |
| 13 | .... | .... | .... | .001 | .01 | .07 | .09 | .02 | .0001 | .19 |
| 14 | .... | .... | .... | .0006 | .007 | .03 | .05 | .01 | .0003 | .10 |
| 15 | .... | .... | .... | .0005 | .003 | .01 | .03 | .007 | .00006 | .05 |
| 16 | .... | .... | .... | .0002 | .001 | .007 | .01 | .004 | .... | .03 |
| 17 | .... | .... | .... | .... | .0007 | .003 | .007 | .002 | .... | .01 |
| 18 | .... | .... | .... | .... | .0002 | .002 | .003 | .0008 | .... | .005 |
| 19 | .... | .... | .... | .... | .0001 | .001 | .001 | .0003 | .... | .003 |
| 20 | .... | .... | .... | .... | .00006 | .0003 | .001 | .0001 | .... | .001 |
| 21 | .... | .... | .... | .... | .... | .00006 | .0006 | .0001 | .... | .0008 |
| 22 | .... | .... | .... | .... | .... | .0001 | .00006 | .00006 | .... | .0003 |
| 23 | .... | .... | .... | .... | .... | .... | .0002 | .... | .... | .0002 |
| 24 | .... | .... | .... | .... | .... | .... | .0003 | .... | .... | .0003 |
| All parities together | 0.08 | 12.37 | 31.38 | 25.49 | 16.89 | 10.19 | 3.31 | 0.29 | 0.0048 | 100 |

## TABLE 11

*Contour surface for live births of 1930 to foreign-born white mothers, by age and parity. Entries are chances in 100*

| PARITY ORDER OF BIRTH | MOTHER'S AGE (*years*) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10-14 | 15-19 | 20-24 | 25-29 | 30-34 | 35-39 | 40-44 | 45-49 | 50 and over | All ages together |
| 1 | 0.007 | 2.7 | 9.9 | 7.7 | 2.9 | 1.0 | 0.2 | 0.01 | .... | 24.34 |
| 2 | .... | .6 | 5.5 | 8.1 | 4.5 | 1.6 | .3 | .02 | .0004 | 20.62 |
| 3 | .... | .1 | 2.4 | 5.0 | 4.6 | 2.1 | .4 | .03 | .0009 | 14.68 |
| 4 | .... | .02 | 1.0 | 3.1 | 3.6 | 2.3 | .5 | .04 | .002 | 10.70 |
| 5 | .... | .002 | .4 | 1.8 | 2.7 | 2.1 | .6 | .04 | .001 | 7.65 |
| 6 | .... | .0004 | .1 | 1.0 | 2.0 | 2.0 | .7 | .05 | .001 | 5.85 |
| 7 | .... | .... | .04 | .5 | 1.4 | 1.8 | .7 | .06 | .0009 | 4.47 |
| 8 | .... | .... | .01 | .2 | 1.0 | 1.6 | .7 | .07 | .001 | 3.59 |
| 9 | .... | .... | .008 | .08 | .5 | 1.3 | .7 | .06 | .... | 2.77 |
| 10 | .... | .... | .001 | .04 | .3 | 1.0 | .7 | .07 | .001 | 2.07 |
| 11 | .... | .... | .004 | .01 | .1 | .6 | .5 | .07 | .0004 | 1.32 |
| 12 | .... | .... | .... | .006 | .07 | .3 | .4 | .06 | .0004 | .86 |
| 13 | .... | .... | .... | .002 | .02 | .2 | .2 | .05 | .0004 | .49 |
| 14 | .... | .... | .... | .0009 | .01 | .09 | .1 | .03 | .... | .27 |
| 15 | .... | .... | .... | .... | .003 | .03 | .08 | .02 | .0009 | .14 |
| 16 | .... | .... | .... | .... | .001 | .02 | .04 | .01 | .... | .08 |
| 17 | .... | .... | .... | .... | .0009 | .009 | .02 | .007 | .... | .03 |
| 18 | .... | .... | .... | .... | .002 | .005 | .01 | .002 | .0004 | .02 |
| 19 | .... | .... | .... | .... | .... | .004 | .002 | .... | .... | .006 |
| 20 | .... | .... | .... | .... | .0009 | .002 | .002 | .0004 | .... | .006 |
| 21 | .... | .... | .... | .... | .... | .0009 | .0004 | .... | .... | .001 |
| 22 | .... | .... | .... | .... | .... | .0004 | .0004 | .0004 | .0004 | .002 |
| 23 | .... | .... | .... | .... | .... | .0004 | .0004 | .0009 | .... | .002 |
| 24 | .... | .... | .... | .... | .... | .0004 | .... | .... | .... | .0004 |
| 25 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| 26 | .... | .... | .... | .... | .... | .... | .... | .... | .... | .... |
| 27 | .... | .... | .... | .... | .... | .... | .... | .0004 | .... | .0004 |
| All parities together | 0.0065 | 3.41 | 19.35 | 27.60 | 23.76 | 18.22 | 6.95 | 0.70 | 0.012 | 100 |

TABLE 12

*Contour surface for live births of 1930 to colored mothers, by age and parity. Entries are chances in 100*

| PARITY ORDER OF BIRTH | MOTHER'S AGE (*years*) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 10-14 | 15-19 | 20-24 | 25-29 | 30-34 | 35-39 | 40-44 | 45-49 | 50 and over | All ages together |
| 1 | 0.6 | 16.0 | 9.2 | 2.1 | 0.7 | 0.3 | 0.05 | 0.006 | 0.0004 | 28.98 |
| 2 | .002 | 4.8 | 8.9 | 2.8 | .9 | .3 | .05 | .007 | .0008 | 17.82 |
| 3 | .... | 1.0 | 6.8 | 3.4 | 1.2 | .5 | .08 | .01 | .001 | 12.94 |
| 4 | .... | .2 | 3.9 | 3.7 | 1.5 | .6 | .1 | .01 | .002 | 9.94 |
| 5 | .... | .04 | 1.7 | 3.3 | 1.8 | .8 | .2 | .02 | .0008 | 7.83 |
| 6 | .... | .01 | .6 | 2.4 | 1.9 | .9 | .2 | .02 | .001 | 6.11 |
| 7 | .... | .0004 | .2 | 1.4 | 1.7 | 1.0 | .2 | .02 | .002 | 4.60 |
| 8 | .... | .... | .1 | .7 | 1.4 | 1.1 | .3 | .04 | .002 | 3.62 |
| 9 | .... | .... | .03 | .3 | .9 | 1.0 | .3 | .03 | .... | 2.60 |
| 10 | .... | .... | .02 | .2 | .6 | .9 | .3 | .04 | .001 | 2.03 |
| 11 | .... | .... | .01 | .07 | .3 | .6 | .3 | .04 | .001 | 1.27 |
| 12 | .... | .... | ... | .03 | .2 | .4 | .3 | .04 | .0004 | .92 |
| 13 | .... | .... | ... | .01 | .07 | .3 | .2 | .04 | .0008 | .57 |
| 14 | .... | .... | ... | .006 | .05 | .1 | .1 | .04 | .0004 | .36 |
| 15 | .... | .... | ... | .004 | .02 | .08 | .08 | .02 | .0004 | .20 |
| 16 | .... | .... | ... | .001 | .009 | .04 | .04 | .02 | .0004 | .10 |
| 17 | .... | .... | ... | .... | .004 | .02 | .02 | .007 | .0008 | .05 |
| 18 | .... | .... | ... | .... | .003 | .008 | .009 | .002 | .... | .02 |
| 19 | .... | .... | ... | .... | .0008 | .005 | .004 | .003 | .0004 | .01 |
| 20 | .... | .... | ... | .... | .... | .005 | .004 | .... | .... | .009 |
| 21 | .... | .... | ... | .... | .... | .001 | .003 | .0004 | .... | .005 |
| 22 | .... | .... | ... | .... | .... | .0008 | .0008 | .... | .... | .002 |
| 23 | .... | .... | ... | .... | .... | .0008 | .... | .... | .... | .0008 |
| 24 | .... | .... | ... | .... | .... | .0004 | .0004 | .0004 | .... | .001 |
| 25 | .... | .... | ... | .... | .... | .... | .0008 | .0004 | .... | .001 |
| 26 | .... | .... | ... | .... | .... | .... | .... | .... | .... | ... |
| 27 | .... | .... | ... | .... | .... | .... | .0008 | .... | .... | .0008 |
| All parities together | 0.61 | 22.08 | 31.50 | 20.64 | 13.04 | 8.96 | 2.73 | 0.42 | 0.02 | 100 |

in 1930 were produced by mothers under 20 years old, only 3.4 percent were produced in the foreign-born white group by mothers under 20. In the colored group, on the other hand, 22.7 percent of all live births were to these young women under 20. Equally striking are the differences at the other end of the age scale. Women aged 35 and over produced, in the native white group, 13.8 percent of the live births, but in the foreign-born white group this percentage was 25.9, nearly twice as great; while in the colored group it was only 12.1.

The extreme concentration of reproductivity within a small area of the whole contour surface is apparent in all these tables. The degree of this can be illustrated in the following way. If we take the 9 cells in each table (a 3 × 3 cell square), representing the highest concentration of reproductivity relative to both parity and mother's age, the boundaries of the square are, for both native and foreign-born whites ages 20-34 and parities 1-3, and for colored are ages 15-29 and parities 1-3. Within these squares are concentrated 54.8 of all live births to native white mothers, 50.6 percent of all live births to foreign-born white mothers, and 55.0 percent of all live births to colored mothers. In other words it appears that, in general, a little more than half the effective reproductivity takes place during a little less than half the average total reproductive span. The other half of the total reproductivity is widely and much more diffusely scattered over the outlying ages and parities. Looking at the matter in another way it appears that over half the live births of 1930 represented something less than adequate reproductivity up to that time on the part of the mothers (III-para or less).

On the parity side of the picture the tables show that in the native white group over 90 percent of all the live births are of parity 6 or below. But in the foreign-born white and colored groups only 84 percent of the live births are of parity 6 or below. These latter two groups definitely tend to have larger families than the native whites. Another way in which this can be shown from the tables is this: just under one live birth in 100 to native white mothers was a tenth live birth, but just over two live births in 100 to foreign-born white and colored mothers was a tenth live birth.

Tables 10-12 analyze the live births by parity and age for each nativity-race(color) group separately. But there are so many more native white mothers in the country as a whole than there are either foreign-born white or colored, that from the point of view of popu-

## TABLE 13

*Contour surface for live births of 1930 to all mothers (native white, foreign-born white, and colored) by age and parity. Entries are chances in*

| PARITY ORDER OF BIRTH | MOTHER'S AGE (*years*), NATIVITY AND COLOR | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 10-14 | | | 15-19 | | | 20-24 | | | 25-29 | | | 30-34 | | | 35-39 | | | 40-44 | | | 45-49 | | | 50 and | | |
| | Nat. W. | For. W. | Col. | Nat. W. | For. W. | Col. | Nat. W. | For. W. | Col. | Nat. W. | For. W. | Col. | Nat. W. | For. W. | Col. | Nat. W. | For. W. | Col. | Nat. W. | For. W. | Col. | Nat. W. | For. W. | Col. | Nat. W. | For. W. | |
| 1 | 0.06 | 0.0007 | 0.07 | 7.5 | 0.3 | 1.9 | 11.1 | 1.1 | 1.1 | 4.8 | 0.8 | 0.3 | 1.6 | 0.3 | 0.08 | 0.5 | 0.1 | 0.03 | 0.09 | 0.02 | 0.006 | 0.006 | 0.001 | 0.0007 | 0.0003 | | |
| 2 | .0002 | ..... | .0002 | 1.7 | .07 | .6 | 7.5 | .6 | 1.1 | 5.1 | .9 | .3 | 2.3 | .5 | .1 | .8 | .2 | .04 | .1 | .03 | .006 | .006 | .002 | .0009 | .0002 | .00 | |
| 3 | ..... | ..... | ..... | .2 | .01 | .1 | 3.6 | .3 | .8 | 3.8 | .6 | .4 | 2.2 | .5 | .1 | .9 | .2 | .05 | .2 | .03 | .01 | .009 | .003 | .001 | .0003 | .00 | |
| 4 | ..... | ..... | ..... | .03 | .002 | .02 | 1.4 | .1 | .5 | 2.7 | .4 | .4 | 1.9 | .4 | .2 | 1.0 | .3 | .07 | .2 | .06 | .01 | .01 | .004 | .003 | .0002 | .00 | |
| 5 | ..... | ..... | ..... | .005 | .0002 | .005 | .4 | .04 | .2 | 1.7 | .2 | .4 | 1.6 | .3 | .2 | .9 | .2 | .1 | .2 | .07 | .02 | .01 | .005 | .003 | .0005 | .00 | |
| 6 | ..... | ..... | ..... | .002 | .00005 | .002 | .1 | .01 | .08 | .9 | .1 | .3 | 1.3 | .2 | .2 | .9 | .2 | .1 | .2 | .07 | .02 | .02 | .005 | .003 | .0003 | .00 | |
| 7 | ..... | ..... | ..... | .... | ..... | .00005 | .03 | .005 | .03 | .4 | .05 | .2 | .9 | .2 | .2 | .8 | .2 | .1 | .3 | .08 | .03 | .02 | .006 | .003 | .0002 | .00 | |
| 8 | ..... | ..... | ..... | .... | ..... | ..... | .009 | .001 | .01 | .1 | .02 | .09 | .6 | .1 | .2 | .7 | .2 | .1 | .3 | .08 | .03 | .02 | .007 | .004 | .0003 | .00 | |
| 9 | ..... | ..... | ..... | .... | ..... | ..... | .003 | .0009 | .004 | .04 | .009 | .04 | .3 | .06 | .1 | 5 | .2 | .1 | .3 | .08 | .03 | .02 | .007 | .004 | .0004 | .. | |
| 10 | ..... | ..... | ..... | .... | ..... | ..... | .001 | .0001 | .002 | .02 | .004 | .02 | .1 | .03 | .07 | .4 | .1 | .1 | .2 | .08 | .04 | .02 | .008 | .005 | .0003 | .00 | |
| 11 | ..... | ..... | ..... | .... | ..... | ..... | .002 | .0005 | .001 | .006 | .001 | .008 | .06 | .01 | .04 | .2 | .07 | .07 | .2 | .06 | .03 | .02 | .008 | .005 | .0002 | .00 | |
| 12 | ..... | ..... | ..... | .... | ..... | ..... | ..... | ..... | .... | .002 | .0006 | .004 | .02 | .008 | .02 | .1 | .04 | .05 | .1 | .05 | .03 | .02 | .007 | .005 | .0001 | .00 | |
| 13 | ..... | ..... | ..... | .... | ..... | ..... | ..... | ..... | .... | .001 | .0002 | .002 | .01 | .003 | .009 | .05 | .02 | .03 | .07 | .03 | .02 | .01 | .006 | .004 | .0001 | .00 | |
| 14 | ..... | ..... | ..... | .... | ..... | ..... | ..... | ..... | .... | .0005 | .0001 | .0007 | .005 | .001 | .006 | .02 | .01 | .02 | .04 | .02 | .02 | .01 | .003 | .004 | .0002 | .. | |
| 15 | ..... | ..... | ..... | .... | ..... | ..... | ..... | ..... | .... | .0004 | ..... | .0004 | .002 | .0003 | .002 | .01 | .004 | .009 | .02 | .009 | .01 | .005 | .003 | .003 | .00005 | .00 | |
| 16 | ..... | ..... | ..... | .... | ..... | ..... | ..... | ..... | .... | .0001 | ..... | .0001 | .0008 | .0001 | .001 | .005 | .003 | .004 | .01 | .005 | .003 | .003 | .001 | .002 | ..... | .. | |
| 17 | ..... | ..... | ..... | .... | ..... | ..... | ..... | ..... | .... | ..... | ..... | ..... | .0005 | .0001 | .0005 | .003 | .001 | .002 | .005 | .002 | .003 | .001 | .0008 | .0008 | ..... | .. | |
| 18 | ..... | ..... | ..... | .... | ..... | ..... | ..... | ..... | .... | ..... | ..... | ..... | .0001 | .0002 | .0003 | .001 | .0005 | .001 | .002 | .001 | .001 | .0006 | .0002 | .0002 | ..... | .00 | |
| 19 | ..... | ..... | ..... | .... | ..... | ..... | ..... | ..... | .... | ..... | ..... | ..... | .0001 | ..... | .0001 | .0008 | .0004 | .0006 | .0009 | .0003 | .0005 | .0003 | ..... | .0004 | ..... | .. | |
| 20 | ..... | ..... | ..... | .... | ..... | ..... | ..... | ..... | .... | ..... | ..... | ..... | .00005 | .0001 | ..... | .0002 | .0002 | .0006 | .0007 | .0002 | .0005 | .0001 | .00005 | ..... | ..... | .. | |
| 21 | ..... | ..... | ..... | .... | ..... | ..... | ..... | ..... | .... | ..... | ..... | ..... | ..... | ..... | ..... | .00005 | .0001 | .0001 | .0004 | .00005 | .0004 | .0001 | ..... | .00005 | ..... | .. | |
| 22 | ..... | ..... | ..... | .... | ..... | ..... | ..... | ..... | .... | ..... | ..... | ..... | ..... | ..... | ..... | .0001 | .00005 | .0001 | .0005 | .00005 | .0001 | .00005 | .00005 | ..... | ..... | .00 | |
| 23 | ..... | ..... | ..... | .... | ..... | ..... | ..... | ..... | .... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | .00005 | .0001 | .0001 | .00005 | ..... | ..... | .0001 | ..... | ..... | .. | |
| 24 | ..... | ..... | ..... | .... | ..... | ..... | ..... | ..... | .... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | .00005 | .00005 | .0002 | ..... | .00005 | ..... | ..... | .00005 | ..... | .. | |
| 25 | ..... | ..... | ..... | .... | ..... | ..... | ..... | ..... | .... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | .0001 | ..... | ..... | .00005 | ..... | .. | |
| 26 | ..... | ..... | ..... | .... | ..... | ..... | ..... | ..... | .... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | .. | |
| 27 | ..... | ..... | ..... | .... | ..... | ..... | ..... | ..... | .... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | .0001 | ..... | .00005 | ..... | ..... | .. | |
| All parities together | 0.06 | 0.0007 | 0.07 | 9.49 | 0.38 | 2.66 | 24.08 | 2.16 | 3.80 | 19.56 | 3.09 | 2.49 | 12.97 | 2.66 | 1.57 | 7.82 | 2.04 | 1.08 | 2.54 | 0.78 | 0.33 | 0.22 | 0.08 | 0.05 | 0.004 | 0.00 | |
| | 0.13 | | | 12.54 | | | 30.05 | | | 25.14 | | | 17.20 | | | 10.94 | | | 3.65 | | | 0.35 | | | 0.0 | | |

LE 13

*n-born white, and colored) by age and parity. Entries are chances in 100*

), NATIVITY AND COLOR

| 35-39 | | | 40-44 | | | 45-49 | | | 50 and over | | | All ages together | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| For. W. | Col. | Nat. W. | For. W. | Col. | Nat. W. | For. W. | Col. | Nat. W. | For. W. | Col. | Nat. W. | For. W. | Col. | |
| 0.1 | 0.03 | 0.09 | 0.02 | 0.006 | 0.006 | 0.001 | 0.0007 | 0.0003 | .... | 0.00005 | 25.62 | 2.75 | 3.50 | 31.84 |
| .2 | .04 | .1 | .03 | .006 | .006 | .002 | .0009 | .0002 | .00005 | .0001 | 17.56 | 2.31 | 2.15 | 22.02 |
| .2 | .05 | .2 | .05 | .01 | .009 | .003 | .001 | .0003 | .0001 | .0001 | 11.05 | 1.64 | 1.56 | 14.25 |
| .3 | .07 | .2 | .06 | .01 | .01 | .004 | .002 | .0002 | .0002 | .0002 | 7.22 | 1.20 | 1.20 | 9.61 |
| .2 | .1 | .2 | .07 | .02 | .01 | .005 | .003 | .0005 | .0001 | .0001 | 4.88 | .86 | .94 | 6.68 |
| .2 | .1 | .2 | .07 | .02 | .02 | .005 | .003 | .0003 | .0001 | .0001 | 3.42 | .65 | .74 | 4.81 |
| .2 | .1 | .3 | .08 | .03 | .02 | .006 | .003 | .0002 | .0001 | .0002 | 2.38 | .50 | .55 | 3.44 |
| .2 | .1 | .3 | .08 | .03 | .02 | .007 | .004 | .0003 | .0001 | .0002 | 1.68 | .40 | .44 | 2.52 |
| .2 | .1 | .3 | .08 | .03 | .02 | .007 | .004 | .0004 | .... | .... | 1.14 | .31 | .31 | 1.76 |
| .1 | .1 | .2 | .08 | .04 | .02 | .008 | .005 | .0003 | .0001 | .0001 | .76 | .23 | .25 | 1.24 |
| .07 | .07 | .2 | .06 | .03 | .02 | .008 | .005 | .0002 | .00005 | .0001 | .46 | .15 | .15 | .76 |
| .04 | .05 | .1 | .05 | .03 | .02 | .007 | .005 | .0001 | .00005 | .00005 | .28 | .10 | .11 | .48 |
| .02 | .03 | .07 | .03 | .02 | .01 | .006 | .004 | .0001 | .00005 | .0001 | .15 | .05 | .07 | .27 |
| .01 | .02 | .04 | .02 | .02 | .01 | .003 | .004 | .0002 | .... | .00005 | .08 | .03 | .04 | .15 |
| .004 | .009 | .02 | .009 | .01 | .005 | .002 | .003 | .00005 | .0001 | .00005 | .04 | .02 | .02 | .08 |
| .003 | .004 | .01 | .005 | .005 | .003 | .001 | .002 | ..... | .... | .00005 | .02 | .009 | .01 | .04 |
| .001 | .002 | .005 | .002 | .003 | .001 | .0008 | .0008 | ..... | .... | .0001 | .01 | .004 | .006 | .02 |
| .0005 | .001 | .002 | .001 | .001 | .0006 | .0002 | .0002 | ..... | .00005 | .... | .004 | .002 | .003 | .009 |
| .0004 | .0006 | .0009 | .0002 | .0005 | .0002 | ..... | .0004 | ..... | .... | .00005 | .002 | .0007 | .002 | .004 |
| .0002 | .0006 | .0007 | .0002 | .0005 | .0001 | .00005 | ..... | ..... | .... | .... | .001 | .0006 | .001 | .003 |
| .0001 | .0001 | .0004 | .00005 | .0004 | .0001 | ..... | .00005 | ..... | .... | .... | .0006 | .0001 | .0006 | .001 |
| .00005 | .0001 | .00005 | .00005 | .0001 | .00005 | .00005 | ..... | ..... | .00005 | .... | .0002 | .0002 | .0002 | .0006 |
| .00005 | .0001 | .0001 | .00005 | ..... | ..... | .0001 | ..... | ..... | .... | .... | .0001 | .0002 | .0001 | .0004 |
| .00005 | .00005 | .0002 | ..... | .00005 | ..... | ..... | .00005 | ..... | .... | .... | .0002 | .00005 | .0001 | .0004 |
| ..... | ..... | ..... | ..... | .0001 | ..... | ..... | .00005 | ..... | .... | .... | ..... | ..... | .0001 | .0001 |
| ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | ..... | .... | .... | ..... | ..... | ..... | ..... |
| ..... | ..... | ..... | ..... | .0001 | ..... | .00005 | ..... | ..... | .... | .... | ..... | .00005 | .0001 | .0001 |
| 2.04 | 1.08 | 2.54 | 0.78 | 0.33 | 0.22 | 0.08 | 0.05 | 0.004 | 0.001 | 0.002 | 76.75 | 11.19 | 12.07 | 100 |
| 10.94 | | | 3.65 | | | 0.35 | | | 0.007 | | | 100.01 | | |

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lation composition and growth the reproductivity of the former group is overwhelmingly more important absolutely than that of either of the other two groups. In order to give a clear view of this point Table 13 is presented. This table takes all the live births of the year 1930 as 100 and distributes them by nativity-race(color), parity, and mother's age.

From Table 13 it is seen that if a person were given no further information than that a particular live baby had been born in the Birth Registration Area in 1930, he could say that there were 11 chances in 100 that that baby had a foreign-born white mother, and 12 chances in 100 that it had a colored mother. If the additional information were given that it was the mother's fifth live birth and that she fell in age between 25 and 29, he could say that there was a chance of 1.7 in 100 that the mother was native white, as against a chance of only 4 in 1000 that the mother was colored. And so on, over the whole table.

Attention has been called above to the fact that the foreign-born whites and colored mothers reproducing in 1930 were making contributions by their births of that year to larger already existing families than were the native whites. Table 13 makes this still more apparent and suggests putting it in a more striking form. This is done in Table 14.

Table 14 is to be read in the following way: the native white mothers of 1930 produced 8.1 *times* as many live births of parities

TABLE 14

*Ratios of the absolute numbers of live births in 1930 of defined parity orders between (a) native white and foreign-born white mothers, and (b) native white and colored mothers.*

| LIVE BIRTHS OF PARITIES | NATIVE WHITE ÷ FOREIGN-BORN WHITE | NATIVE WHITE ÷ COLORED |
|---|---|---|
| 1- 3 | 8.1 | 7.5 |
| 4- 6 | 5.7 | 5.4 |
| 7- 9 | 4.3 | 4.0 |
| 10-12 | 3.1 | 2.9 |
| 13-15 | 2.7 | 2.1 |
| 16-18 | 2.3 | 1.8 |
| 19 and over | 2.2 | 1.0 |

1-3 inclusive as did foreign-born white mothers, but only 5.7 *times* as many live births of parities 4-6 inclusive. And so on for other cells. The essential point brought out by Table 14 is that as the order of the live births of the year increased, the relative superiority of the native white group over the other two nativity-race(color) groups in respect of absolute contribution to the reproductivity of the year steadily and smoothly declined.

*(To be Continued)*

# THE DISTRIBUTION OF SEX RATIOS WITHIN FAMILIES IN AN OHIO CITY

## STUDIES IN HUMAN INHERITANCE, XVI.

BY D. CECIL RIFE AND L. H. SNYDER

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THE determination of sex is a favorite topic for popular discussion. Although biologists have clearly demonstrated that in higher animals, as a rule, the sex of the individual is usually determined at the time of fertilization, apparently depending upon the type of sex chromosome present in the sperm, the general public is skeptical and numerous other theories of sex determination are in vogue. The fact that it is possible to reverse the sex in numerous plants by altering certain environmental conditions, such as length of day, type of nutrition and moisture supply has possibly increased this skepticism. Undoubtedly in the past biologists have been too dogmatic in asserting that the sex of an individual depends entirely on the type of sex chromosomes present. Present day geneticists are more of the belief that the sex of an individual is determined, under ordinary environmental conditions, by genetic factors located on both the autosomes and sex chromosomes, the number and kind of sex chromosomes in relation to the number of autosomes present in an individual determining whether the individual will possess a preponderance of factors for maleness or femaleness. Thus sex is quantitative rather than qualitative, and by changing environmental conditions sufficiently the sex may also be shifted. While numerous cases of sex reversal are known in plants, they are quite rare in higher animals.

If in man sex is determined at the time of conception, depending upon whether the sperm carries an X or a Y chromosome, and the environment plays little or no part in the sex determination of the individual, then the ratios of girls to boys within families in the general population should give normal distributions. Thus we could predict

how frequently in families of any given number of children we should obtain all boys or all girls, or any given ratio of boys to girls. If such a population study should reveal that the boy-girl ratios do not follow a normal distribution, we could be reasonably certain that factors other than the chance meeting of sperm and egg play a part in the determination of sex in human beings.

In order to obtain information in regard to sex ratios within families a population study, the results of which are recorded in this article, was made in Grandview Heights, a city of between six and seven thousand population, located near Columbus, O. The entire population is white, and the parents are of both native and foreign extraction, predominantly native. The social-economic status is undoubtedly higher than that of the average American city, there being no slum district.

The information recorded here was obtained by a house to house canvas. Because of the greater mortality of boys than of girls in infancy, our calculations are based on children born, rather than on living children. Wherever one or more parents were living, the total number of births was recorded, regardless of age, habitat or marital state of the offspring. Thus in some homes, where three generations were living, it was possible to record the offspring of two sets of parents. Remarkable coöperation was obtained, information being withheld in only two instances. Names and house numbers were not recorded, and this may have been a factor in the general willingness to coöperate.

A total of 1760 homes were visited, but in 117 homes it was impossible to obtain the desired information, due to absence of the occupants or inability of those present to give accurate data. The information obtained from the 1643 families interviewed is as follows:

*Total families interviewed=1643*

| | | | | | |
|---|---|---|---|---|---|
| No children | 322 | | | | |
| One child | 431 | ..... | 1 boy | | 218 |
| | | | 1 girl | | 213 |
| Two children | 458 | ..... | 2 boys | | 115 |
| | | | 1 boy, | 1 girl | 234 |
| | | | 2 girls | | 109 |

*Total families interview=1643 (continued)*

| | | | | |
|---|---|---|---|---|
| Three children | 241 | ..... | 3 boys | 29 |
| | | | 2 boys, 1 girl | 90 |
| | | | 1 boy, 2 girls | 93 |
| | | | 3 girls | 29 |
| Four children | 90 | ..... | 4 boys | 5 |
| | | | 3 boys, 1 girl | 22 |
| | | | 2 boys, 2 girls | 37 |
| | | | 1 boy, 3 girls | 19 |
| | | | 4 girls | 7 |
| Five children | 49 | ..... | 5 boys | 1 |
| | | | 4 boys, 1 girl | 8 |
| | | | 3 boys, 2 girls | 14 |
| | | | 2 boys, 3 girls | 16 |
| | | | 1 boy, 4 girls | 7 |
| | | | 5 girls | 3 |
| Six children | 17 | ..... | 6 boys | 1 |
| | | | 5 boys, 1 girl | 2 |
| | | | 4 boys, 2 girls | 3 |
| | | | 3 boys, 3 girls | 5 |
| | | | 2 boys, 4 girls | 3 |
| | | | 1 boy, 5 girls | 1 |
| | | | 6 girls | 2 |
| Seven children | 16 | ..... | 6 boys, 1 girl | 2 |
| | | | 5 boys, 2 girls | 3 |
| | | | 4 boys, 3 girls | 6 |
| | | | 3 boys, 4 girls | 3 |
| | | | 2 boys, 5 girls | 1 |
| | | | 1 boy, 6 girls | 1 |
| Eight children | 7 | ..... | 6 boys, 2 girls | 1 |
| | | | 5 boys, 3 girls | 3 |
| | | | 4 boys, 4 girls | 2 |
| | | | 3 boys, 5 girls | 1 |
| Nine children | 4 | ..... | 7 boys, 2 girls | 1 |
| | | | 5 boys, 4 girls | 2 |
| | | | 3 boys, 6 girls | 1 |
| Ten children | 3 | ..... | 7 boys, 3 girls | 2 |
| | | | 5 boys, 5 girls | 1 |

*Total families interview=1643 (continued)*

| | | | |
|---|---|---|---|
| Eleven children | 3 | 7 boys, 4 girls | 2 |
| | | 6 boys, 5 girls | 1 |
| Twelve children | 0 | | |
| Thirteen children | 0 | | |
| Fourteen children | 2 | 5 boys, 9 girls | 1 |
| | | 3 boys, 11 girls | 1 |

Total offspring ..... 3072
Total males ..... 1551
Total females ..... 1521
Sex ratio=101.97 males to 100 females

The United States Census for 1930* shows a ratio of 102.5 males to 100 females, a ratio close to that obtained in our own investigation. An inspection of the ratios within families shows that they approach a normal distribution. In the families of five or less children the numbers are sufficient to enable a statistical analysis. Thus, if we allow $p$ to represent the proportion of males, and $q$ the proportion of female offspring in the population studied, we find;

$$p + q = 1$$
$$p = .505$$
$$q = .495$$

If $n$ = the number of offspring in the family, then $(p + q)^n = p^n$ (all males) $+ np^{n-1}q^1$ ($n$—1 males, 1 female)$\ldots\ldots q^n$ (all females). Applying this method to families of five and less offspring, we find the following actual and predicted ratios of males to females within families:

| *No. offspring* | *Ratio ♂ to ♀* | *Actual* | *Predicted* |
|---|---|---|---|
| 1 | 1 ♂ | .506 | .505 ± .015‡ |
| | 1 ♀ | .494 | .495 ± .015 |
| 2 | 2 ♂ | .251 | .255 ± .014 |
| | 1 ♂ 1 ♀ | .510 | .500 ± .016 |
| | 2 ♀ | .239 | .245 ± .013 |

*Fifteenth census of the U. S., Population, Vol. II.

| *No. offspring* | *Ratio ♂ to ♀* | *Actual* | *Predicted* |
|---|---|---|---|
| 3 | 3♂ | .120 | .129 ± .014 |
| | 2♂ 1♀ | .374 | .379 ± .021 |
| | 1♂ 2♀ | .386 | .371 ± .021 |
| | 3♀ | .120 | .121 ± .014 |
| 4 | 4♂ | .055 | .066 ± .017 |
| | 3♂ 1♀ | .244 | .255 ± .031 |
| | 2♂ 2♀ | .410 | .375 ± .034 |
| | 1♂ 3♀ | .211 | .244 ± .030 |
| | 4♀ | .066 | .060 ± .016 |
| 5 | 5♂ | .020 | .033 ± .016 |
| | 4♂ 1♀ | .163 | .163 ± .035 |
| | 3♂ 2♀ | .286 | .316 ± .044 |
| | 2♂ 3♀ | .326 | .309 ± .043 |
| | 1♂ 4♀ | .143 | .150 ± .031 |
| | 5♀ | .061 | .029 ± .016 |

$$\text{P.E.} = .6745\sqrt{\frac{pq}{n}}$$

The distribution of sex ratios within families of five or less offspring corresponds very closely with that predicted. In only three instances does the discrepency between the actual and the predicted exceed the probable error of the predicted, and in no instance is it greater than twice the probable error. The findings of this research indicate that the sex of an individual is determined on a purely chance basis.

# NOTES

## A HISTORICAL ERROR CORRECTED

IN A monograph[1] recently published by the German Statistical Office, in connection with the latest German life table, the fundamental equation for the true rate of natural increase

$$1 = \int_0^w e^{-rx} l_x f_x dx$$

is credited to L. v. Bortkiewicz.

This is an error probably traceable to the publications of R. Kuczynski. That it must be an error is clear from the fact that Bortkiewicz nowhere introduces into his discussion or into his formulae fertility function[2] $f_x$, without which it is of course impossible to determine the true rate of natural increase $r$ by the formula cited or by any other formula.

In his recent book, The Measurement of Population Growth, Kuczynski repeats this error of his earlier publications. He remarks (p. 226) "Bortkiewicz had come to the conclusion that a population constantly subject to the same mortality and *with a constant rate of increase must ultimately become stable*, that is to say have a stable age composition, a stable birth rate and a stable death rate."

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[1]Neue Beiträge zum deutschen Bevölkerungsproblem, *Berlin* 1935, p. 79. In the footnote (2) on this page of the monograph the year of publication of the formula in the *Journal of the American Statistical Association* is also incorrectly stated as 1929—the actual date of the publication was 1925. The formula was first given by Sharpe and Lotka in *Phil. Mag.* 1911, vol. 21, p. 435.

[2]Kuczynski himself admits this in his otherwise misleading account of the history of the concept of the "stable" population in Fertility and Reproduction, Falcon Press, 1932. On page 43 of this we read: "He (Bortkiewicz) does not touch fertility at all."

What Bortkiewicz[3] actually did show is that *if* the age distribution in a closed population *is constant*, and if the mortality is in accordance with a constant life table, then the population must be increasing at a constant rate per head.[4]

In other words, what Kuczynski states as a *conclusion* of Bortkiewicz's article, was actually Bortkiewicz's *hypothesis*, and what Kuczynski states as Bortkiewicz's hypothesis was actually his conclusion.

On page 224, Kuczynski says: "He (Bortkiewicz) starts from the stationary population according to the German life table for 1891-1900 and shows what *will be the ultimate* age composition, that is the age composition of the stable population, if the population increases every year by 7, 14, 21 or 28 per thousand." Here again Kuczynski either has misunderstood or misinterpreted Bortkiewicz. The latter does not "start from the stationary population.....[5] and show

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[3]L. v. Bortkiewicz: Die Sterbeziffer und der Frauen-überschuss in der stationären und in der progressiven Bevölkerung, Bulletin de l'Institut International de Statistique, 1911, vol. XIX, No. 1, pp. 63-138. Bortkiewicz's wording regarding the assumptions underlying his development are perfectly clearly stated in his opening paragraph which I quote here verbatim, together with the second paragraph which closely bears on the first.

"Den nachfolgenden Darlegungen liegen drei einschränkende Voraussetzungen zu Grunde. Es wird angenommen: 1. dass in der Bevölkerung eine unveränderliche Absterbeordnung herrscht; 2. dass die Altersverteilung der jeweilig Lebenden ebenfalls unveränderlich ist, und 3. dass keine Ein- und Auswanderung stattfindet.

"Demnach erscheinen die "statiönare" und die "progressive" Bevölkerung in dem Sinne, wie diese Termini hier gebraucht werden, gleichsam als Idealtypen, denen die Wirklichkeit niemals genau entspricht, denen sie aber um so näher kommt, je unerheblicher die thatsächlich vor sich gehenden Wandlungen der Absterbeordnung und der Altersverteilung und je geringer, relativ genommen, die Zahlen der Ein- und Auswandernden sind."

[4]If for a population having a constant life table and a constant age distribution the rate of increase is *known*, then the age distribution can be calculated. But Bortkiewicz tells us nothing that would enable us to compute the *unknown* ultimate rate of increase of a population which has a variable, not a constant age distribution.

[5]Kuczynski's misunderstanding is perhaps based on a passage in Bortkiewicz's French summary, in which, on page 140, he speaks of "calculer, en partant d'une table de survie determinée, quel serait le taux de mortalité dans une population

what *will be the ultimate* stable population." What he does is to compute the age distribution in a population, which for a long time past has had a given mortality (life table) and a constant rate of natural increase per head, of *arbitrarily assumed values* (7, 14, 21, 28); and Bortkiewicz then shows that the age distribution so computed, on the basis of the *actually observed rate* of natural increase, namely 14 per thousand in Germany at the time cited, agrees well with the observed age distribution.

All this was old in the literature (which Kuczynski fails to point out); precisely the same reasoning had been applied and the same conclusions and formulae reached by Lotka in 1907, and his results had been compared and found to agree with the age distribution of England and Wales, 1871-1880, in precisely the same manner that Bortkiewicz had compared his computed age distribution with that of Germany.

Nowhere in Bortkiewicz's paper is there any mention of age-specific fertility. This in itself makes it quite clear that Bortkiewicz could not have computed the stable rate of natural increase. What happened is that he struck a population in which the actual rate of natural increase was the same as the stable rate, because at the period of his example the rate of natural increase had for many years been approximately constant.

If Bortkiewicz had really done what Kuczynski in the passage cited declares that he did, namely started from a stationary population and showed what would be the ultimate age distribution, what need was there for Kuczynski to go through the agonizing labor of testing the process of approach from the life table age distribution to the stable age distribution, as described by him in his *Numerical Example*[6] covering 15 pages of closely printed figures?

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soumise a cette table de survie et augmentant regulièrement d'année en année dans telle ou telle proportion."

The words "en partant d'une table de survie determinée" do not mean "starting from a stationary population," but "on the basis of a given life table." Even to one who might have failed to understand the French idiom here, the meaning must be clear not only from the entire context, but also from the closing clause of the sentence "dans une population soumise a cette table de survie, et augmentant regulièrement d'année en année." A stationary population does not increase regularly from year to year.

[6] R. Kuczynski. Fertility and Reproduction, Falcon Press, 1932, p. 65.

Actually this test was unnecessary in any case. Perhaps, however, it has served the useful purpose of showing how Kuczynski's own work contradicts his statements regarding Bortkiewicz.

It should further be remarked that Kuczynski's statements cited above from his page 226 is inherently absurd, for if a population has a constant rate (per head) of natural increase, a constant age-specific mortality, and a constant age-specific fecundity, it *is* in the "stable" age distribution from the very start, and to say that it will ultimately become stable is futile.

The word "age-specific," and the words "and a constant age-specific fecundity" are not in Kuczynski's original and have been inserted by me in the preceding paragraph; but they are evidently to be understood, for unless they are so inserted there is no basis whatever for the statement that the population will approach a stable age distribution.

If to Dr. Kuczynski the substitution of a converse theorem for the original seems a logical operation, let him be reminded that the truth of a converse by no means follows from the original theorem, and, in this particular case, that the proof of the ultimate approach to the stable age distribution and its concomitant characteristics requires methods fundamentally different from anything to be found in Bortkiewicz's paper. This must be abundantly clear to anyone who takes the trouble to examine the pertinent publications, from the first crude approach by Euler (based on highly unrealistic assumptions, and quite inapplicable to actual statistical data), through the publications of A. J. Lotka, J. B. S. Haldane, H. T. F. Norton, R. A. Fisher, S. Wicksell, F. Bonz and F. Hilburg, to mention only a few of the authors who have written competently on this subject.

Since the erroneous presentation of the history of this case has filtered through from Kuczynski's writings into responsible publications, as in the case cited in the opening paragraph, it seemed desirable to draw attention to these facts.

ALFRED J. LOTKA

# RECENT LITERATURE

USEFUL IN THE STUDY OF HUMAN BIOLOGY

In this department will be noticed the books and reprints which are currently received at the Editorial Office. Publications intended for notice here should be addressed to Dr. Raymond Pearl, Department of Biology, School of Hygiene and Public Health, 1901 East Madison Street, Baltimore, Maryland, U. S. A.

## I. EVOLUTION AND GENETICS

### 1. *Evolution—General Principles*

BOYDEN, ALAN. Serology and biological problems. *Sigma Xi Quarterly*, Vol. 24, pp. 152-160, 1936. [Bibliography of 35 titles.]

CLEMENTS, FREDERICK E., and RALPH W. CHANEY. Environment and Life in the Great Plains. *Carnegie Institution of Washington, Supplementary Publications* No. 24, 1936. Pp. 54. 10 × 6¾ inches. [Bibliography of 77 titles.]

FRANCIS, W. D. The magnetic interpretation of life based upon experimental evidence. "Issued at *Brisbane*," September 11, 1936. Pp. 14 + 1 plate. [Bibliography of 7 titles.]

GRANGER, WALTER, and WILLIAM K. GREGORY. Further notes on the gigantic extinct rhinoceros, *Baluchitherium*, from the oligocene of Mongolia. *Bulletin of the American Museum of Natural History*, Vol. 72, pp. 1-73 + 4 plates, 1936. [Bibliography of 2 pages.]

GREGORY, WILLIAM K. Habitus factors in the skeleton of fossil and recent mammals. *Proceedings American Philosophical Society*, Vol. 76, pp. 429-444 + 1 chart, 1936. [1 bibliographic footnote.]

GREGORY, WILLIAM K. On the phylogenetic relationships of the giant panda (*Ailuropoda*) to other arctoid carnivora. *American Museum Novitates*, No. 878, pp. 29, 1936. [Bibliography of 23 titles.]

GREGORY, WILLIAM K. The transformation of organic designs: a review of the origin and development of the earlier vertebrates. *Biological Reviews*, Vol. 11, pp. 311-344, 1936. [Bibliography of 3 pages.]

GREGORY, WILLIAM K., and G. MILES CONRAD. Pictorial phylogenies of deep sea Isospondyli and Iniomi. *Copeia*, No. 1, pp. 21-36, 1936. [Bibliography of 40 titles.]

GREGORY, WILLIAM K., and G. MILES CONRAD. The evolution of the pediculate fishes. *American Naturalist*, Vol. 70, pp. 193-208, 1936. [Bibliography of 15 titles.]

KINSEY, ALFRED C. The Origin of Higher Categories in Cynips. *Indiana University Publications, Science Series* No. 4. *Bloomington, Ind.* (Indiana Univer-

sity Bookstore), 1936. Pp. 334. 10 × 7 inches. $2.50 (paper). [Bibliography of 6 pages.]

MacClintock, Paul, E. H. Barbour, C. B. Schultz, and A. L. Lugn. A pleistocene lake in the White River Valley. *American Naturalist*, Vol. 70, pp. 346-360. [Bibliographic footnotes.]

McAtee, W. L. The rôle of fitness in evolution. *Ohio Journal of Science*, Vol. 36, pp. 237-241, 1936. [Bibliography of 11 titles.]

McAtee, W. L. The postulated resemblance of natural to artificial selection. *Ohio Journal of Science*, Vol. 36, pp. 242-252, 1936. [Bibliography of 21 titles.]

Osborn, Henry Fairfield. Edited by Mabel R. Percy. Proboscidea. A Monograph of the Discovery, Evolution, Migration and Extinction of the Mastodonts and Elephants of the World. Volume 1: Mœritherioidea, Deinotherioidea, Mastodontoidea. *New York* (The American Museum Press), 1936. Pp. xl + 802 + 2 folding charts. 12½ × 10¾ inches. $20.00. [Bibliography of 42 pages.]

Porto, César. Transformisme et Hérédité. Les Organismes et le Milieu Terrestre. *Lisbon* (Librairie Bertrand), 1936. Pp. viii + 328 + 4 folding charts. 9 × 5½ inches. 15 francs (paper).

Stock, Chester. The succession of mammalian forms within the period in which human remains are known to occur in America. *American Naturalist*, Vol. 70, pp. 324-331, 1936.

Volterra, V. La théorie mathématique de la lutte pour la vie et l'expérience. (A propos de deux ouvrages récents de C. F. Gause). *Scientia*, Vol. 60, pp. 169-174, 1936. [Bibliographic footnotes.]

Watson, D. M. S., and others. A discussion on the present state of the theory of natural selection. *Proceedings of the Royal Society of London*, Ser. B, Vol. 121, pp. 43-72, 1936. [Bibliography of 9 titles.]

### 2. *Human Evolution*

Antevs, Ernst. Dating records of early man in the Southwest. *American Naturalist*, Vol. 70, pp. 331-336, 1936. [5 bibliographic footnotes.]

Gregory, William K. Nature's upstart: *Homo sapiens*. *The Teaching Biologist*, Vol. 5, pp. 22-25; 30-31, 1935. [Bibliography of 2 titles.]

Richards, Horace G. Mollusks associated with early man in the Southwest. *American Naturalist*, Vol. 70, pp. 369-371, 1936. [5 bibliographic footnotes.]

Rode, K. Wesen und Ursprung der Menschheit nach Dacqué. *Zeitschrift für Rassenkunde*, Bd. 4, pp. 318-319, 1936.

Weidenreich, Franz. *Sinanthropus pekinensis* and its position in the line of human evolution. *Peking Natural History Bulletin*, Vol. 10, pp. 281-290, 1936.

### 3. *Prehistory and Archaeology*

Douglass, A. E. Dating Pueblo Bonito and Other Ruins of the Southwest. Pueblo Bonito Series, Number 1. *Washington* (National Geographic Society), 1935. Pp. 74. 10 × 6½ inches. $1.00 (paper). [Bibliography of 2 pages.]

HOWARD, EDGAR B. The association of a human culture with an extinct fauna in New Mexico. *American Naturalist*, Vol. 70, pp. 314-323, 1936.

KÜHN, HERBERT. Menschendarstellungen im Paläolithikum. *Zeitschrift für Rassenkunde*, Bd. 4, pp. 225-247, 1936. [63 bibliographic footnotes.]

MCGREGOR, J. C. Culture of Sites which were Occupied shortly before the Eruption of Sunset Crater. *Museum of Northern Arizona, Bulletin* 9. *Flagstaff, Arizona* (Northern Arizona Society of Science and Art), 1936. Pp. 52. 8¼ × 5½ inches. 60 cents (paper). [Bibliography of 10 titles.]

ROBERTS, FRANK H. H., JR. Recent discoveries of the material culture of Folsom man. *American Naturalist*, Vol. 70, pp. 337-345, 1936.

SELLARDS, E. H. Recent studies of early man in the southwestern part of the United States. *American Naturalist*, Vol. 70, pp. 361-368, 1936.

UNIVERSITY OF NEW MEXICO BULLETIN. Symposium on Prehistoric Agriculture. *Anthropological Series, Whole Number* 296. *Albuquerque* (University of New Mexico Press), 1936. Pp. 72. 9 × 5⅞ inches (paper). [Bibliographic footnotes.]

### 4. *Genetics — General Principles*

ELDER, JAMES H. Report of a case of inherited polymastia in chimpanzee. *Anatomical Record*, Vol. 65, pp. 83-87, 1936. [Bibliography of 13 titles.]

HALDANE, J. B. S. The amount of heterozygosis to be expected in an approximately pure line. *Journal of Genetics*, Vol. 32, pp. 375-391, 1936. [Bibliography of 15 titles.]

SCHÄFER, WILHELM. Über die Zunahme der Isozygotie (Gleicherbigkeit) bei fortgesetzter Bruder-Schwester-Inzucht. *Zeitschrift für induktive Abstammungs-und Vererbungslehre*, Vol. 72, pp. 50-79, 1936. [Bibliography of 14 titles.]

WATERS, NELSON F., and W. V. LAMBERT. A ten year inbreeding experiment in the domestic fowl. *Poultry Science*, Vol 15, pp. 207-218, 1936. [Bibliography of 7 titles.]

### 5. *Human Heredity*

ALCOBÉ, S. Die Blutgruppen der iberischen Halbinsel. *Zeitschrift für Rassenkunde*, Bd. 4, p. 318, 1936.

ARDASHNIKOV, S. N., E. A. LICHTENSTEIN, R. P. MARTYNOVA, G. V. SOBOLEVA, and E. N. POSTNIKOVA. On the diagnosis of zygosity of twins. *Proceedings of the Maxim Gorky Medico-Genetical Research Institute, Moscow*, Vol. 4, pp. 254-283, 1936. [Bibliography of 6 titles.] [In Russian with English summary.]

BOSSIK, L. J., and E. E. PASSYNKOFF. Therapeutic studies of identical twins. Communication II. *Proceedings of the Maxim Gorky Medico-Genetical Research Institute, Moscow*, Vol. 4, pp. 466-486, 1936. [In Russian with English summary.]

FRETS, G. P. Erbkrank und erbgesund. *Bevölkerungsfragen. Bericht des Internationalen Kongresses für Bevölkerungswissenschaft, Berlin, 26. August—1. September 1935*, pp. 694-705, 1936.

FRETS, G. P. Erbliche Belastung in der Durchschnittsbevölkerung. *Genetica*, Vol. 18, pp. 66-96, 1936. [Bibliographic footnotes.]

GASSKO, S. M. Clinico-genetical investigation of paroxysmal tachycardia (preliminary report). *Proceedings of the Maxim Gorky Medico-Genetical Research Institute, Moscow*, Vol. 4, pp. 140-148, 1936. [Bibliography of 9 titles.] [In Russian with English summary.]

GATES, R. RUGGLES. Recent progress in blood group investigations. *Genetica*, Vol. 28, pp. 47-65, 1936. [Bibliography of 49 titles.]

GATES, R. RUGGLES. Tibetan blood-groups. *Man*, Vol. 36, pp. 110-111, 1936.

GRAVES, WILLIAM W. Note sur une relation éventuelle entre les groupes sanguins, l'age et la longévité. *L'Anthropologie*. T. 45, pp. 601-608, 1935. [Bibliography of 20 titles.]

HALDANE, J. B. S. A search for incomplete sex-linkage in man. *Annals of Eugenics*, Vol. 7, pp. 28-57, 1936. [Bibliography of 28 titles.]

IGNATIEV, M. V. On the mathematical interpretation of twin correlations. *Proceedings of the Maxim Gorky Medico-Genetical Research Institute, Moscow*, Vol. 4, pp. 284-295, 1936. [Bibliography of 6 titles.] [In Russian with English summary.]

LEVIN, A. E., and B. A. KUCHUR. On the clinico-genetical differentiation of ulcer disease. *Proceedings of the Maxim Gorky Medico-Genetical Research Institute, Moscow*, Vol. 4, pp. 181-194, 1936. [Bibliography of 8 titles.] [In Russian with English summary.]

LEVIN, A. E., and B. A. KUCHUR. An investigation of the secretory functions of the stomach in families of ulcerous patients. *Proceedings of the Maxim Gorky Medico-Genetical Research Institute, Moscow*, Vol. 4, pp. 195-200, 1936. [Bibliography of 12 titles.] [In Russian with English summary.]

LEVIT, S. G. The problem of dominance in man. *Proceedings of the Maxim Gorky Medico-Genetical Research Institute, Moscow*, Vol. 4, pp. 17-40, 1936. [Bibliography of 44 titles.] [In Russian with English summary.]

LEVIT, S. G., and L. N. PESSIKOVA. Is diabetes insipidus caused by a "good" dominant gene? *Proceedings of the Maxim Gorky Medico-Genetical Research Institute, Moscow*, Vol. 4, pp. 149-158, 1936. [Bibliography of 11 titles.] [In Russian with English summary.]

LICHTENSTEIN, E. A., and I. L. BASSINA. An investigation of the mouth cavity in twins. Communication I. Cariosity. *Proceedings of the Maxim Gorky Medico-Genetical Research Institute, Moscow*, Vol. 4, pp. 305-327, 1936. [Bibliography of 13 titles.] [In Russian with English summary.]

LICHTENSTEIN, E. A., and I. L. BASSINA. An investigation of the mouth cavity in twins. Communication II. First and second teething, morphology and disposition of teeth. *Proceedings of the Maxim Gorky Medico-Genetical Research Institute, Moscow*, Vol. 4, pp. 328-352, 1936. [Bibliography of 29 titles.] [In Russian with English summary.]

LURIA, A. R., and A. N. MIRENOVA. Experimental development of constructive activity (differential training of identical twins). Communication III. Stability of the effect of training. *Proceedings of the Maxim Gorky Medico-Genetical Research Institute, Moscow,* Vol. 4, pp. 487-505, 1936. [Bibliography of 1 title.] [In Russian with English summary.]

MALKOVA, N. N. Clinico-genetical investigation of bronchial asthma and other allergic diseases. *Proceedings of the Maxim Gorky Medico-Genetical Research Institute, Moscow,* Vol. 4, pp. 41-107, 1936. [Bibliography of 90 titles.] [In Russian with English summary.]

MARTYNOVA, R. P. On the genetics of cancer of the breast in women. *Proceedings of the Maxim Gorky Medico-Genetical Research Institute, Moscow,* Vol. 4, pp. 159-180, 1936. [Bibliography of 55 titles.] [In Russian with English summary.]

PELLER, SIGISMUND. Rasse und Krebs. *Acta Cancrologica,* Vol. 1, pp. 3-21, 1934. [13 bibliographic footnotes.]

PRESNYAKOV, D. F. Clinico-genetical investigation of pernicious anemia. *Proceedings of the Maxim Gorky Medico-Genetical Research Institute, Moscow,* Vol. 4, pp. 108-139, 1936. [Bibliography of 52 titles.] [In Russian with English summary.]

PRYOR, JOSEPH W. Ossification as additional evidence in differentiating identicals and fraternals in multiple births. *American Journal of Anatomy,* Vol. 59, pp. 409-423, 1936. [Bibliography of 3 titles.]

[ROESLE, E. E.] Die Grundlagen der vergleichenden Familienbiologie. *Familienbiologie und Familienkulture,* Bd. 2, pp. 3-24, 1936.

RYVKIN, I. A. An investigation of the electrocardiogram in twins. Communication IV. Some correlations of physiological and pathological characteristics of the heart. *Proceedings of the Maxim Gorky Medico-Genetical Research Institute, Moscow,* Vol. 4, pp. 440-465, 1936. [Bibliography of 3 pages.] [In Russian with English summary.]

TSHETVERIKOV, N. S. Some statistical formulae of use in twin studies. *Proceedings of the Maxim Gorky Medico-Genetical Research Institute, Moscow,* Vol. 4, pp. 296-304, 1936. [Bibliography of 5 titles.] [In Russian with English summary.]

VOLOTZKOY, M. V. On the genetics of fingerprints. *Proceedings of the Maxim Gorky Medico-Genetical Research Institute, Moscow,* Vol. 4, pp. 404-439, 1936. [Bibliography of 45 titles.] [In Russian with English summary.]

WEITZ, WILHELM. Die Vererbung innerer Krankheiten. *Stuttgart* (Ferdinand Enke), 1936. Pp. xi + 197. 9¼ × 6¼ inches. RM. 13 (paper); RM. 14.60 (cloth). [Extensive bibliography throughout.]

WIENER, ALEXANDER S. The inheritance of allergic disease. *Ohio Journal of Science,* Vol. 36, pp. 147-148, 1936. [Bibliography of 6 titles.]

WIENER, ALEXANDER S., I. ZIEVE, and JOSEPH H. FRIES. The inheritance of allergic disease. *Annals of Eugenics,* Vol. 7, pp. 141-162, 1936. [Bibliography of 25 titles.]

ZIEVE, I., ALEXANDER S. WIENER, and JOSEPH H. FRIES. On the linkage relations of the genes for allergic disease and the genes determining the blood groups,

MN types and eye colour in man. *Annals of Eugenics*, Vol. 7, pp. 163-178, 1936. [Bibliography of 16 titles.]

### 6. *Eugenics*

THE COMMITTEE OF THE AMERICAN NEUROLOGICAL ASSOCIATION FOR THE INVESTIGATION OF EUGENICAL STERILIZATION: ABRAHAM MYERSON, JAMES B. AYER, TRACY J. PUTNAM, CLYDE E. KEELER, and LEO ALEXANDER. Eugenical Sterilization. A Reorientation of the Problem. *New York* (The Macmillan Co.), 1936. Pp. xii + 211. 8½ × 5½ inches. $3.00. [Bibliography of 20 pages.]

OSBORN, FREDERICK. Measures of quality in the study of population. *Annals of the American Academy of Political and Social Science*, Vol. 188, pp. 194-204, 1936. [Bibliographic footnotes.]

ROESLE, E. E. Die Feuerlein in Franken und die Entwicklung des Ramsberg-Weissenburger Stammes vom 16. bis 18. Jahrhundert. *Mitteilungen des Familienverbandes Feuerlein*, Jahrg. 2, pp. 33-64, 1936.

SAVORGNAN, FRANCO. Das Schicksal eines russischen Fürstengeschlechtes nach der Revolution. *Bevölkerungsfragen. Bericht des Internationalen Kongresses für Bevölkerungswissenschaft, Berlin, 26. August-1. September 1935*, pp. 348-352, 1936. [Bibliographic footnotes.]

## II. GROUP BIOLOGY

### 1. *Environment of Man*

CHENG, S. K. Chinese Cookery Book. *London* (The Shanghai Restaurant), 1936. Pp. viii + 102. 7¼ × 4¾ inches. 3s. 9d.

CLAPP, EARLE H. The Major Range Problems and their Solution. Résumé of a Report prepared in Response to Senate Resolution 289, together with Letters of Transmittal, Table of Contents, Etc. *Forest Service, U. S. Department of Agriculture. Senate Document* No. 199—*Separate* No. 1. *Washington* (U. S. Government Printing Office), 1936. Pp. xvi + 69. 9¼ × 5¾ inches (paper).

DEDICHEN, HETNA. 88 Danish Dishes or Dining in Denmark. *Copenhagen* (Andr. Fred. Høst and Son), 1936. Pp. 65. 7¾ × 5¼ inches. Kr. 3 (paper).

DEXTER, SMITH O. [Editor.] October Farm. From the Concord Journals and Diaries of William Brewster. Introduction by Daniel C. French. *Cambridge* (Harvard University Press), 1936. Pp. xv + 285 + 5 plates. 7½ × 5¼ inches. $2.50.

KENNEDY, WALTER P., and IAN MACKAY. The normal leucocyte picture in a hot climate. *Journal of Physiology*, Vol. 87, pp. 336-344, 1936. [Bibliography of 13 titles.]

LESTER, ALLEN H., and DONALD G. FERGUSON. Your Food Supply. *Cambridge* (American Institute for Economic Research), 1936. Pp. 62. 8½ × 5½ inches. $1.00 (paper).

MILLS, C. A. Acute appendicitis and the weather. *Journal of Medicine*, March 1934. Pp. (of reprint) 7. [Bibliography of 6 titles.]

MILLS, C. A. Artificial climate—a new service to hospital patients. *Modern Hospital*, Vol. 43, pp. (of reprint) 3, 1934. [Bibliography of 3 titles.]

MILLS, C. A. Health and disease as influenced by climatic environment. *International Clinics*, Vol. 11, pp. 143-167, 1936. [Bibliography of 17 titles.]

MILLS, C. A. The relation of climate to functional disturbances in the body. *Ohio State Medical Journal*, March 1936. Pp. (of reprint) 4.

MILLS, C. A. World temperatures and the population problem. Written at the request of the *Associated Press*, and released for publication August 9, 1936. Pp. 3.

MILLS, C. A. Deserts in the making, or the problem of the Western Plains. Written at the request of the *Associated Press*, and released for publication August 16, 1936. Pp. 2.

MILLS, C. A. Northward shifting of the storm belts; fluctuations in climatic characteristics. Written at the request of the *Associated Press*, and released for publication August 23, 1936. Pp. 4.

MILLS, C. A. Heat deaths—sensitivity to heat. Written at the request of the *Associated Press*, and released for publication August 30, 1936. Pp. 3.

MILLS, C. A. Climatic fluctuations: piecing together the evidence. Written at the request of the *Associated Press*, and released for publication September 6, 1936. Pp. 3.

ROTHAMSTED EXPERIMENTAL STATION. Lawes Agricultural Trust, Report for 1935. *St. Albans* (Gibbs and Bamforth), 1936. Pp. 278. 9¾ × 6 inches. 2s. 6d. (paper).

SCHOENICHEN, WALTHER. Urdeutschland. Deutschlands Naturschutzgebiete in Wort und Bild. Lieferungen 21, 22, 23. *Neudamm* (J. Neumann), 1936. Lief. 21, pp. 193-216 + 9 plates; Lief. 22, pp. 217-240 + 9 plates; Lief. 23, pp. 241-280 + 9 plates. 10¾ × 8¼ inches. 2 marks each (paper).

SWEETMAN, HARVEY L. The Biological Control of Insects. With a Chapter on Weed Control. Foreword by L. O. Howard. *Ithaca* (Comstock Publishing Co.), 1936. Pp. xii + 461. 9 × 6 inches. $3.75. [Bibliography of 30½ pages.]

U. S. DEPARTMENT OF AGRICULTURE. Agricultural Statistics 1936. *Washington* (Government Printing Office), 1936. Pp. 421. 9¼ × 5¾ inches. 50 cents (paper).

YANOVSKY, ELIAS. Food Plants of the North American Indians. *U. S. Department of Agriculture Miscellaneous Publication* No. 237. *Washington* (Government Printing Office), 1936. Pp. 84. 9⅛ × 6 inches. 10 cents (paper).

### 2. *Public Health and Hygiene*

BOLDUAN, CHARLES F. Diabetes as a public health problem. *Preventive Medicine*, Vol. 6, pp. 7-17, 1936.

CH'EN, C. C. The development of systematic training in the rural public health work in China. *Milbank Memorial Fund Quarterly*, Vol. 14, pp. 370-387, 1936.

CURRIE, J. R., and Contributors. Laboratory Practice. Manual of Public Health. *Baltimore* (William Wood and Co.), 1936. Pp. xix + 378. 8½ × 5½ inches. $6.75.

DEUTSCH, NAOMI, and HORTENSE HILBERT. Public health nursing under the Social Security Act. *Public Health Nursing*, September 1936. Pp. (of reprint) 4.

DOWNES, JEAN. A study of the effectiveness of certain administrative procedures in tuberculosis control. *Milbank Memorial Fund Quarterly*, Vol. 14, pp. 317-327, 1936. [1 bibliographic footnote.]

LANDE, HERMAN. The preventive aspects of diabetes. *Preventive Medicine*, Vol. 6, pp. 17-19, 1936.

LEAGUE OF NATIONS. Quarterly Bulletin of the Health Organisation, Vol. 5, No. 3, pp. 391-570, 1936. *Geneva* (League of Nations); *New York* (World Peace Foundation). 9½ × 6⅛ inches. 65 cents (paper).

LEWIS, RUTH L. The frequency of city health department services for infants. *Milbank Memorial Fund Quarterly*, Vol. 14, pp. 362-369, 1936. [Bibliographic footnotes.]

RANDALL, MARIAN G. The value of records. *Public Health Nursing*, October 1936. Pp. (of reprint) 6. [Bibliographic footnotes.]

ROCKEFELLER FOUNDATION, INTERNATIONAL HEALTH DIVISION. Annual Report 1935. *49 West 49th St., New York*, 1936. Pp. viii + 285. 8⅝ × 5¾ inches.

WIEHL, DOROTHY G. Measuring health needs in an urban district. *Milbank Memorial Fund Quarterly*, Vol. 14, pp. 345-361, 1936. [Bibliographic footnotes.]

### 3. *Migration*

CONSEIL SANITAIRE MARITIME ET QUARANTENAIRE D'EGYPTE. Rapport sur le Pèlerinage au Hedjaz de l'Année de l'Hégire 1354 (A.D. 1936). *Alexandrie*, (Société de Publications Egyptiennes), 1936. Pp. 126 + 7 plates + 5 folding tables. 12½ × 9¼ inches. Free (paper).

DORN, HAROLD F., and FRANK LORIMER. Migration, reproduction, and population adjustment. *Annals of the American Academy of Political and Social Science*, Vol. 188, pp. 280-289, 1936. [Bibliographic footnotes.]

GOODRICH, CARTER. Internal migration and economic opportunity. *Annals of the American Academy of Political and Social Science*, Vol. 188, pp. 260-263, 1936. [Bibliographic footnotes.]

HAMILTON, C. HORACE. The annual rate of departure of rural youths from their parental homes. *Rural Sociology*, Vol. 1, pp. 164-179, 1936.

### 4. *Population*

BAKER, O. E. Rural and urban distribution of the population in the United States. *Annals of the American Academy of Political and Social Science*, Vol. 188, pp. 264-279, 1936. [Bibliographic footnotes.]

BLACK, JOHN D. Agricultural population in relation to agricultural resources. *Annals of the American Academy of Political and Social Science*, Vol. 188, pp. 205-217, 1936.

BODENHEIMER, F. S. Équilibre et capacité de l'espace vital dans le monde vivant. *Scientia*, Vol. 59, pp. 137-148, 1936.

BODENHEIMER, F. S. Factors controlling locust populations. *Cairo* (Government Press), 1936. Pp. (of reprint) 11.

BODENHEIMER, F. S. Studies in animal populations. I. Red scale populations in orange-groves of various ages in Palestine. *Hadar*, Vol. 9, No. 3, 1936. Pp. (of reprint) 8.

COLTON, HAROLD S. The rise and fall of the prehistoric population of Northern Arizona. *Science*, Vol. 84, pp. 337-343, 1936. [Bibliographic footnotes.]

HALDANE, J. B. S. Some natural populations of *Lythrum salicaria*. *Journal of Genetics*, Vol. 32, pp. 393-397, 1936. [Bibliography of 7 titles.]

HILL, JOSEPH A. Composition of the American population by race and country of origin. *Annals of the American Academy of Political and Social Science*, Vol. 188, pp. 177-184, 1936.

IGNATIEV, M. V., and T. I. PROKOFYEVA. Data on inbreeding in the Moscow population. *Proceedings of the Maxim Gorky Medico-Genetical Research Institute, Moscow*, Vol. 4, pp. 201-212, 1936. [Bibliography of 8 titles.] [In Russian with English summary.]

NICEFORO, ALFREDO. La recensement des habitations italiennes. *Revue Le Assicurazioni Sociali*, Vol. 12, No. 3, 1936. Pp. (of reprint) 44. [Bibliographic footnotes.]

PELLER, SIGISMUND. Die jüdische Ärzteschaft in Palästina. *Palästina*, Bd. 19. Heft 3, 1936. Pp. (of reprint) 11. [Bibliographic footnotes.]

PELLER, SIGISMUND. Die natürliche Bevölkerungsbewegung als Grundlage sozialbiologischer Betrachtung des Judenproblems in Palästina. *Palästina*, Bd. 19, Heft 5 and 6, 1935. Pp. (of reprint) 19. [Bibliographic footnotes.]

REED, LOWELL J. Population growth and forecasts. *Annals of the American Academy of Political and Social Science*, Vol. 188, pp. 159-166, 1936. [Bibliographic footnotes.]

SHRYOCK, HENRY S., JR. Population estimates in postcensal years. *Annals of the American Academy of Political and Social Science*, Vol. 188, pp. 167-176, 1936. [Bibliographic footnotes.]

SNOW, WILLIAM F. Venereal diseases and sex abnormalities in relation to population growth. *Annals of the American Academy of Political and Social Science*, Vol. 188, pp. 70-77, 1936. [Bibliographic footnotes.]

STEPHAN, FREDERICK F. Sources of population data. *Annals of the American Academy of Political and Social Science*, Vol. 188, pp. 351-359, 1936.

THOMPSON, WARREN S. The distribution of population. *Annals of the American Academy of Political and Social Science*, Vol. 188, pp. 250-259, 1936. [Bibliographic footnotes.]

THOMPSON, WARREN S., and P. K. WHELPTON. Population policies of European countries. *Annals of the American Academy of Political and Social Science*, Vol. 188, pp. 297-306, 1936. [Bibliographic footnotes.]

TRUESDELL, LEON E. Value of the population census for research. *Annals of the American Academy of Political and Social Science*, Vol. 188, pp. 329-339, 1936. [1 bibliographic footnote.]

VOLTERRA, VITO. Le principe de la moindre action en biologie. *Comptes rendus des séances de l'Académie des Sciences*, Vol. 203, pp. 417 ff. 1936. [Bibliographic footnotes.]

VOLTERRA, VITO. Les équations canoniques des fluctuations biologiques. *Comptes rendus des séances de l'Académie des Sciences,* Vol. 202, pp. 2023 ff., 1936. [1 bibliographic footnote.]

VOLTERRA, VITO. Les équations des fluctuations biologiques et le calcul des variations. *Comptes rendus des séances de l'Académie des Sciences,* Vol. 202, pp. 1953 ff., 1936. [Bibliographic footnotes.]

VOLTERRA, VITO. Sur l'intégration des équations des fluctuations biologiques. *Comptes rendus des séances de l'Académie des Sciences,* Vol. 202, pp. 2113 ff., 1936. [1 bibliographic footnote.]

VOLTERRA, VITO. Sur la moindre action vitale. *Comptes rendus des séances de l'Académie des Sciences,* Vol. 203, p. 480 ff., 1936. [Bibliographic footnotes.]

WAITE, WARREN C., and JOHN D. BLACK. Nutrition and agricultural policy. *Annals of the American Academy of Political and Social Science,* Vol. 188, pp. 218-229, 1936. [Bibliographic footnotes.]

### 5. *Mortality and General Vital Statistics*

BÖHMERT. WILHELM. Untersuchung über die Todesfälle an Krebs in den grossen Städten der Welt. XXIII[e] *Session de l'Institut International de Statistique, Athènes,* 1936. Pp. (of reprint) 73.

BUREAU OF THE CENSUS. Vital Statistics Summary for Montana: 1935. *Vital Statistics—Special Reports, Washington, D. C.,* September 28, 1936, Vol. 2, No. 8, pp. 77-89.

BUREAU OF THE CENSUS. Vital Statistics Summary for Maryland: 1935. *Vital Statistics—Special Reports, Washington, D. C.,* October 2, 1936, Vol. 2, No. 9, pp. 91-102.

BUREAU OF THE CENSUS. Vital Statistics Summary for Florida: 1935. *Vital Statistics—Special Reports, Washington, D. C.,* October 8, 1936, Vol. 2, No. 10, pp. 103-115.

BUREAU OF THE CENSUS. Vital Statistics Summary for Maine: 1935. *Vital Statistics—Special Report, Washington, D. C.,* October 13, 1936, Vol. 2, No. 11, pp. 117-128.

DUNN, HALBERT L. Vital statistics collected by the government. *Annals of the American Academy of Political and Social Science,* Vol. 188, pp. 340-350, 1936.

EDGE, P. GRANVILLE. The contents of colonial medical reports. A note. *Supplement to the Tropical Diseases Bulletin,* October 1936, pp. 3-6.

HOFFMAN, WILLIAM J. Industrial and occupational cancer. *Preventive Medicine,* Vol. 6, pp. 7-34, 1936. [Bibliography of 49 titles.]

PERROTT, G. ST. J. The state of the nation's health. *Annals of the American Academy of Political and Social Science,* Vol. 188, pp. 131-143, 1936. [Bibliographic footnotes.]

SAND, RENÉ. Changes in the death rate since the seventeenth century. *Milbank Memorial Fund Quarterly,* Vol. 14, pp. 311-316, 1936.

SOUTH AFRICA. Report of the Vital Statistics of the Union of South Africa 1934. *Pretoria* (The Government Printer), 1936. Pp. liii + 83 + 1 map. 12 × 9¾ inches. 4s. (paper). [In English and Dutch.]

WOODBURY, ROBERT M. Infant mortality in the United States. *Annals of the American Academy of Political and Social Science*, Vol. 188, pp. 94-106, 1936. [Bibliographic footnotes.]

### 6. *Morbidity and Epidemiology*

COMMITTEE ON IODINE DEFICIENCY AND THYROID DISEASE, with sections by MATTHEW YOUNG, M. G. CRABTREE, and E. M. MASON. The Relationship of the Iodine Contents of Water, Milk and Pasture to the Occurrence of Endemic Goitre in Two Districts of England. *Medical Research Council, Special Series*, No. 217. *London* (H. M. Stationery Office), 1936. Pp. 20. 9⅝ × 6 inches. 6d. net (paper).

GEAR, H. S. Disease incidence in China. An analysis of hospital records for 1934 Chinese Medical Association Hospital Survey. *Chinese Medical Journal*, Vol. 50, pp. 949-972, 1936. [Bibliography of 12 titles.]

HILL, A. BRADFORD, and K. MITRA. Enteric fever in milk-borne and water-borne epidemics. A comparison of age- and sex-incidence. *Lancet*, Vol. 231, pp. 589-594, 1936. [Bibliography of 7 titles.]

HOLMES, ARTHUR D., MADELINE G. PIGOTT, WM. ALFRED SAWYER, and LAURA COMSTOCK. Cod liver oil. A five-year study of its value for reducing industrial absenteeism caused by colds and respiratory diseases. *Industrial Medicine*, July 1936. Pp. (of reprint) 4. [Bibliography of 32 titles.]

NAIVE, J. B. The menace of the tuberculous Negro domestic. Address delivered at the annual meeting of the Southern Tuberculosis Conference and the Southern Sanatorium Association, Houston, Texas, September 16, 17, 18, 1935. *Sanatorium, Texas* (Miss. Tbc. Assoc.). Pp. (of reprint) 2.

NELSON, N. A. Gonorrhea. *Milbank Memorial Fund Quarterly*, Vol. 14, pp. 328-344. [Bibliographic footnotes.]

U. S. TREASURY DEPARTMENT, PUBLIC HEALTH SERVICE. Epidemic Amebic Dysentery. The Chicago Outbreak of 1933. *National Institute of Health Bulletin* No. 166. *Washington* (Government Printing Office), 1936. Pp. xi + 187 + 2 plates + 3 folding charts. 9¼ × 5¾ inches. 20 cents (paper).

### 7. *Natality, Fecundity, Fertility*

DE BERARDINIS, LUIGI. Rapporto sulle statistiche dei nati morti e sulla natimortalita. XXIII[e] *Session de l'Institut International de Statistique, Athènes*, 1936. Pp. (of reprint) 34. [Bibliographic footnotes.]

ELDER, J. H., and R. M. YERKES. Chimpanzee births in captivity: a typical case history and report of sixteen births. *Proceedings of the Royal Society*, Ser. B, Vol. 120, pp. 409-421, 1936. [Bibliography of 21 titles.]

LOTKA, ALFRED J. Modern trends in the birth rate. *Annals of the American Academy of Political and Social Science*, Vol. 188, pp. 1-13, 1936. [Bibliographic footnotes.]

NOTESTEIN, FRANK W. Class differences in fertility. *Annals of the American Academy of Political and Social Science*, Vol. 188, pp. 26-36, 1936. [Bibliographic footnotes.]

OGLE, CORDELIA. Adaptation of sexual activity to environmental stimulation. *American Journal of Physiology*, Vol. 107, pp. 628-634, 1934. [Bibliography of 5 titles.]

OGLE, CORDELIA, and C. A. MILLS. Adaptation of sexual activity to environmental stimulation. *American Journal of Physiology*, Vol. 105, p. 75, 1933.

PEARL, RAYMOND. Biological factors in fertility. *Annals of the American Academy of Political and Social Science*, Vol. 188, pp. 14-25, 1936. [Bibliographic footnotes.]

SHOROHOVA, A. A. The Method of Studying of Human Fertility. *Tashkent* (State Publisher U.S.S.R.), 1935. Pp. 95. 10 × 6¾ inches. [In Russian with English summary.]

WHELPTON, P. K. Geographic and economic differentials in fertility. *Annals of the American Academy of Political and Social Science*, Vol. 188, pp. 37-55, 1936. [Bibliographic footnotes.]

YERKES, ROBERT M., and JAMES H. ELDER. The sexual and reproductive cycles of chimpanzee. *Proceedings of the National Academy of Sciences*, Vol. 22, pp. 276-283, 1936. [Bibliography of 2 titles.]

### 8. *Birth Control*

[Vacant]

### 9. *Marriage and Divorce*

STOUFFER, SAMUEL A., and LYLE M. SPENCER. Marriage and divorce in recent years. *Annals of the American Academy of Political and Social Science*, Vol. 188, pp. 56-69, 1936. [Bibliographic footnotes.]

## III. BEHAVIOR

### 1. *Racial and Genetic Psychology*

MANDEL. HERMANN. Rassenkundliche Geistesgeschichte auf biologischer Grundlage. *Zeitschrift für Rassenkunde*, Bd. 4. pp. 250-268, 1936. [Bibliography of 11 titles.]

NISSEN, H. W., C. R. CARPENTER, and J. T. COWLES. Stimulus- versus response-differentiation in delayed reactions of chimpanzees. *Journal of Genetic Psychology*, Vol. 48, pp. 112-136, 1936. [Bibliography of 11 titles.]

PORTO, CÉSAR. L'Instinct. Ses Causes Physiques, sa Base Organique et sa Psychologie. *Paris* (José Corti), 1935. Pp. 288. 9 × 5½ inches. 15 francs (paper).

SPENCE, KENNETH W. The nature of discrimination learning in animals. *Psychological Review*, Vol. 43, pp. 427-449, 1936. [Bibliography of 19 titles.]

YERKES, ROBERT M. A chimpanzee family. *Journal of Genetic Psychology*, Vol. 48, pp. 362-370, 1936. [Bibliography of 16 titles.]

YERKES, ROBERT M., and JAMES H. ELDER. Oestrus, Receptivity, and Mating in Chimpanzee. *Comparative Psychology Monographs*, Vol. 13, Serial No. 65.

*Baltimore* (Johns Hopkins Press), 1936. Pp. 39. 10 × 6¾ inches. 75 cents (paper). [Bibliographic footnotes.]

YERKES, ROBERT M., and ADA W. YERKES. Nature and conditions of avoidance (fear) response in chimpanzee. *Journal of Comparative Psychology*, Vol, 21, pp. 53-66, 1936. [1 bibliographic footnote.]

### 2. *Individual Psychology*

DORROS, THEODORE. Intelligence. (This book is not for sale.) 1936. Pp. 153. 8¾ × 5¾ inches (paper).

GEORGE, WILLIAM H. The Scientist in Action. A Scientific Study of his Methods. *London* (Williams and Norgate), 1936. Pp. 355. 8½ × 5½ inches. 10s. 6d. net. [Bibliography of 2½ pages.]

PRESTON, MARY I. Child guidance in out-patient pediatrics. A study of 500 consecutive patients. *Journal of Pediatrics*, Vol. 7, pp. 452 ff., 1935.

RITCHIE, A. D. The Natural History of Mind. Tarner Lectures delivered in Trinity College, Cambridge, 1935. *New York* (Longmans, Green and Co.), 1936. Pp. viii + 285. 8½ × 5½ inches. $4.50. [Bibliographic footnotes.]

TERMAN, LEWIS M., and CATHARINE C. MILES, assisted by JACK W. DUNLAP, HAROLD K. EDGERTON, E. LOWELL KELLY, ALBERT D. KURTZ, E. ALICE MCANULTY, QUINN MCNEMAR, MAUD A. MERRILL, FLOYD L. RUCH, and HORACE G. WYATT. Sex and Personality. Studies in Masculinity and Femininity. *New York* (McGraw-Hill Book Co.), 1936. Pp. xii + 600. 9 × 6 inches. $4.50. [Bibliographic footnotes.]

WHITE, WENDELL. The Psychology of Dealing with People. Appealing to the Want for a Feeling of Personal Worth. *New York* (The Macmillan Co.), 1936. Pp. xiv + 256. 7¾ + 5½ inches. $2.50. [Bibliographic footnotes.]

### 3. *Psychiatry*

GANTT, W. HORSLEY. An experimental approach to psychiatry. *American Journal of Psychiatry*, Vol. 92, pp. 1007-1021, 1936. [Bibliographic footnotes.]

ISRAELI, NATHAN. Abnormal Personality and Time. With a Foreward by Irving J. Sands, and Introduction by Gardner Murphy. *Lancaster* (Science Press Printing Co.), 1936. Pp. 123. 9 × 6 inches. $2.50. [Bibliography of 82 titles.]

LEWIS, NOLAN D. C. Research in Dementia Precox (Past Attainments, Present Trends and Future Possibilities). *New York* (National Committee for Mental Hygiene), 1936. Pp. xi + 320. 9 × 6 inches. $1.50. [Bibliography of 7 pages.]

MALZBERG, BENJAMIN. Rates of mental disease among certain population groups in New York State. *Journal of the American Statistical Association*, Vol. 31, pp. 545-548. [7 bibliographic footnotes.]

OVERHOLSER, WINFRED. Address delivered before Members of the Supreme Council, 33°, A. A. S. R., N. M. J., in Open Committee Session, at *Atlantic City, New Jersey*, on September 22, 1936. Pp. 16.

SYZ, HANS. Posttraumatic loss of reproductive memory and its restoration through hypnosis and analysis. *Medical Record*, October 7, 1936. Pp. (of reprint) 12 . [Bibliography of 16 titles.]

THOMPSON, CHARLES B. Some new aspects of the psychiatric approach to crime. *Mental Hygiene*, Vol. 20, pp. 529-545, 1936. [Bibliographic footnotes.]

### 4. *History and Biography*

ALVAREZ, WALTER C. The emergence of modern medicine from ancient folkways. *Sigma Xi Quarterly*, Vol. 24, pp. 135-151, 1936.

COATS, R. H. Statistics comes of age. *Canadian Journal of Economics and Political Science*, Vol. 2, pp. 269-287, 1936. [Bibliographic footnotes.]

EDGE, P. GRANVILLE. The genealogy of vital statistics. *Malayan Medical Journal*, Vol. 8, 1933; Vol. 9, 1934. Pp. (of reprint) 35. [Bibliographic footnotes.]

GREGORY, WILLIAM K. Henry Fairfield Osborn. *Proceedings American Philosophical Society*, Vol. 76, pp. 395-408, 1936.

HALLOWELL, A. IRVING. Anthropology — Yesterday and today. *Sigma Xi Quarterly*, Vol. 24, pp. 161-169, 1936. [Bibliography of 10 titles.]

KELLY, EMERSON CROSBY [Compiled by.] Medical Classics. Volume 1, Number 1. *Baltimore* (Williams and Wilkins Co.), 1936. Pp. 78. 10 × 7 inches. Subscription price $10.00 per volume; single copies $1.25 (paper). [Bibliography of Sir James Paget of 15½ pages.]

MOEWES, FRANZ, WERNER WEBER, HANS SCHWENKEL, KURT MÜLLER, and WALTER EFFENBERGER. Festschrift zum 60. Geburtstage von Professor Dr. Walther Schoenichen gewidmet von seinen Freunden und Mitarbeitern und von dem Verlage J. Neumann in Neudamm. Textbeilege zur Zeitschrift *"Naturschutz"*, Jahrg. 17, Heft 7, 1936. Pp. 16.

REID, EDITH G. The Life and Convictions of William Sidney Thayer, Physician. *New York* (Oxford University Press), 1936. Pp. xii + 243. 8½ × 5½ inches. $2.50.

ROURKE, CONSTANCE. Audubon. *New York* (Harcourt, Brace and Co.), 1936. Pp. 342 + 12 plates. 8¾ × 6¼ inches. $3.00.

SCHWIDETZKY, I. Anthropologie und Geschichtswissenschaft. *Zeitschrift für Rassenkunde*, Bd. 4, pp. 268-284, 1936. [Bibliographic footnotes.]

SULLIVAN, E. C. Arthur Louis Day. *Industrial and Engineering Chemistry*, Vol. 28, p. 347, 1936.

WOOLLEY, SIR LEONARD. Abraham. Recent Discoveries and Hebrew Origins. *New York* (Charles Scribner's Sons), 1936. Pp. 299. 7⅞ × 5½ inches. $3.00.

### 5. *Sociology, Law, Politics and Religion*

ALLENBY, VISCOUNT. World police for world peace. *International Conciliation*, No. 323, pp. 479-486, 1936.

AMERICAN LIBERTY LEAGUE. The Dual Form of Government and the New Deal. *Document No. 134, Washington*, September 1936. Pp. 22. 9 × 4 inches.

ATKINSON, MARY IRENE. Organizing for child welfare grants-in-aid. *Social Service Review*, Vol. 10, pp. 464-482, 1936.

BLUM, LÉON. France faithful to democracy. *International Conciliation*, No. 323, pp. 524-527, 1936.

CARNEGIE ENDOWMENT FOR INTERNATIONAL PEACE. The Federation of India, by Lord Linlithgow. Speech of Chancellor Hitler at Nuremberg, September 9, 1936. Text of German Evangelical Church Letter submitted to Chancellor Hitler in June, 1936. Text of German Evangelical Church Manifesto of August 23, 1936. Address of Pope Pius XI to Spanish Refugees, September 14, 1936. *International Conciliation*, November, 1936, No. 324. *New York*. Pp. 531-583. 7¾ × 5 inches. 5 cents (paper).

CHANDLER, O. K., and A. L. JEMISON. Now Who's Un-American? An Expose of Communism in the United States Government. *Washington, D. C.* (The American Indian Federation), 1936. Pp. 35. 9 × 6¾ inches. 25 cents (paper).

GEBHART, JOHN C. Is Government Worth What It Costs? *New York* (The National Economy League), 1936. Pp. 14. 9 × 4 inches.

GIUSTI, UGO. Sono possibili e utili comparazioni internazionali puramente statistiche sulle spese di famiglia e sui consumi individuali di particolari gruppi sociali? XXIII[e] *Session de l'Institut International de Statistique, Athènes*, 1936. Pp. (of reprint) 10. [2 bibliographic footnotes.]

HOPKINS, ERNEST M. Thoughts current. *Atlantic Monthly*, Vol. 158, pp. 385-391, 1936.

HULL, CORDELL. The responsibility of governments and peoples. *International Conciliation*, No. 323, pp. 487-490, 1936.

HULL, CORDELL. American foreign relations. *International Conciliation*, No. 323. pp. 515-523, 1936.

KEMP, TAGE. Prostitution. An Investigation of Its Causes, Especially with Regard to Hereditary Factors. *Copenhagen* (Levin and Munksgaard); *London* (William Heinemann), 1936. Pp. 253. 10 × 7½ inches. Dan. Cr. 12 (cloth); Dan. Cr. 10 (paper). [Bibliography of 6 pages.]

KROFTA, KAMIL. Europe at the crossroads. *International Conciliation*, No. 323, pp. 491-514, 1936.

PERKINS, WILLIAM R. A Rising or a Setting Sun? *Document* No. 135. *Washington* (American Liberty League), 1936. Pp. 30. 9 × 4 inches.

ULREY, LEWIS V. Radicalism in the church. *National Republic Magazine*, July 1936. Pp. (of reprint) 2.

U. S. DEPARTMENT OF LABOR, CHILDREN'S BUREAU. Juvenile-Court Statistics and Federal Juvenile Offenders, 1933. Based on Information Supplied by 284 Juvenile Courts and by the United States Department of Justice. Seventh Annual Report. Bureau Publication No. 232. *Washington* (U. S. Government Printing Office), 1936. Pp. iv + 114. 9¼ + 5⅞ inches. 10 cents (paper).

VAN VALKENBURGH, RICHARD. Navajo common law I. Notes on political organization, property and inheritance. *Museum Notes*, Vol. 9, pp. 17-22, 1936.

### 6. *Economics*

BAEKELAND, LEO HENDRIK. Impress of chemistry upon industry. *Industrial and Engineering Chemistry*, Vol. 27, pp. 538-543, 1935.

DIRECCION GENERAL DE ESTADISTICA. Memoria de los Censos de 1935. Primer Censo Ejidal Segundo Censo Industrial. Mexico, 1935. *Mexico*, 1936. Pp. 247. 9 × 6¾ inches (paper).

EZEKIEL, MORDECAI. Population and unemployment. *Annals of the American Academy of Political and Social Science*, Vol. 188, pp. 230-242, 1936. [Bibliographic footnotes.]

HAMILTON, C. HORACE. The status and future of farm tenantry in the South. *Commercial Fertilizer 1936 "Year Book"*. Pp. (of reprint) 6. [Bibliographic footnotes.]

HULL, CORDELL. American foreign trade policies. *International Conciliation*, No. 323, pp. 453-465, 1936.

INTERNATIONAL LABOUR OFFICE. Year-Book of Labour Statistics 1935-36. *Geneva*, 1936. Pp. viii + 227. 9½ × 6¼ inches. $1.50 (paper); $2.50 (cloth). (U. S. Agents: World Peace Foundation, 40 Mt. Vernon St., Boston).

MILLS, CLARENCE A. The weather's effect on man and business activity. *Cincinnati Alumnus*, Vol. 6. Pp. (of reprint) 5, 1936.

MOLINARI, A. Statistiques de la distribution. XXIII[e] *Session de l'Institut International de Statistique, Athènes*, 1936. Pp. (of reprint) 32. [Bibliographic footnotes.]

ROBBINS, LIONEL. The consequences of economic nationalism. *International Conciliation*, No. 323, pp. 466-478, 1936.

SOUTH AFRICA. Census of Industrial Establishments. Statistics of Factories and Productive Industries (excluding Mining and Quarrying) in the Union for the Year 1933-34. (Seventeenth Industrial Census, 1935). *Pretoria* (The Government Printer), 1936. Pp. xii + 81. 13 × 8 inches. 3s. (paper). [In English and Dutch.]

WILLETT, HERBERT. The Weekly Wholesale Price Index. *Washington* (The National Fertilizer Association), 1936. Pp. 23. 9 × 6 inches.

### 7. *Education*

CORWIN, E. H. L., and GERTRUDE E. STURGES. Opportunities for the Medical Education of Negroes. Introduction by Walter L. Niles, and a Foreword by Walter White. *New York* (Charles Scribner's Sons), 1936. Pp. xv + 293. 7½ × 5¼ inches. $1.50.

GREGORY, WILLIAM K. The museum of things versus the museum of ideas. *Science*, Vol. 83, pp. 585-588, 1936.

LANGDON-BROWN, SIR WALTER, R. G. MACDONALD LADELL, FRANK GRAY, and F. G. CROOKSHANK. The Place of Psychology in the Medical Curriculum and Other Papers. *Individual Psychology Medical Pamphlets* No. 16. *London* (C. W. Daniel Co.), 1936. Pp. 56. 8½ × 5½ inches. 2s. 6d. net (paper). [Bibliography of 20 titles.]

SADLER, WILLIAM S. Psychiatric educational work. *Address read at the Ninety-second Annual Meeting of the American Psychiatric Association*, May 4-8, 1936. Pp. (of reprint) 32.

### 8. *Ethnology, Cultural Anthropology, Travel and Exploration*

BAIKOV, N. Big Game Hunting in Manchuria. Adapted from the Russian by Serge Ivanoff and Gertrude Mack. *London* (Hutchinson and Co.), 1936. Pp. 285 + 17 plates. 9 × 6 inches. 18s. net.

BUXTON, L. H. DUDLEY, [Editor.] Custom is King. Essays Presented to R. R. Marett on His Seventieth Birthday June 13, 1936. *London* (Hutchinson's Scientific and Technical Publications), 1936. Pp. xiii + 325 + 4 plates. 8½ × 5½ inches. 12s. 6d. [Bibliographic footnotes throughout.] [Bibliography of 23 pages of the scientific writings of R. R. Marett.]

COLLUM, V. C. C. "Race-nations" as biological entities. A plea for the biological method of studying civilisation. *Zeitschrift für Rassenkunde, Bd. 4, pp. 306-317*, 1936.

GATES, R. RUGGLES. The Eskimos: their past and future. *Nature*, Vol. 137, p. 722, 1936.

HUTCHINSON, G. EVELYN. The Clear Mirror. A Pattern of Life in Goa and in Indian Tibet. *Cambridge* (The University Press); *New York* (The Macmillan Co.), 1936. Pp. xi + 171 + 13 plates. 8¾ × 5½ inches. $2.50.

LOVE, J. R. B. Stone-Age Bushmen of To-day. Life and Adventure among a Tribe of Savages in North-Western Australia. *London and Glasgow* (Blackie and Son), 1936. Pp. xxiii + 220 + 16 plates. 8½ × 5½ inches. 8s. 6d. net.

MERRITT-HAWKES, O. A. High Up in Mexico. *London* (Ivor Nicholson and Watson), 1936. Pp. xi + 279 + 17 illustrations. 8¾ × 5⅜ inches. 15s. net.

SCHEBESTA, PAUL. Der Urwald ruft wieder. Meine zweite Forschungsreise zu den Ituri-Zwergen. *Salzburg and Leipzig* (Anton Pustet), 1936. Pp. 208 + 40 plates + 1 folding map. 9 × 6 inches. GM. 6 (paper).

WIGRAM, W. A., and EDGAR T. A. WIGRAM. The Cradle of Mankind. Life in Eastern Kurdistan. Second Edition. *London* (A. and C. Black); *New York* (The Macmillan Co.), 1922. Pp. xi + 430 + 16 illustrations + 1 folding map. 8½ × 5½ inches. $4.00.

WILLIAMS, JOSEPH J. Africa's God. III. Nigeria. *Anthropological Series of the Boston College Graduate School*, Vol. 1, No. 3. *Chestnut Hill, Mass.* (Boston College Press), 1936. Pp. 56. 9¾ × 6½ inches. $1.00 (paper). [Bibliography of 6 pages.]

WYNDHAM, RICHARD. The Gentle Savage. A Sudanese Journey in the Province of Bahr-el-Ghazal, commonly called "The Bog". *New York* (William Morrow and Co.), 1936. Pp. 287. 8½ × 5¾ inches. $2.75.

## IV. SOMATOLOGY AND CONSTITUTION

### 1. *Anatomy*

ANDRES, A. H., and M. S. NAVASHIN. Morphological analysis of human chromosomes. *Proceedings of the Maxim Gorky Medico-Genetical Research Insti-*

*tute, Moscow*, Vol. 4, pp. 506-524, 1936. [Bibliography of 11 titles.] [In Russian with English summary.]

ANDRES, A. H., and J. I. VÖGEL. Karyological investigation of oogenesis in man. I. Embryonal oogenesis. *Proceedings of the Maxim Gorky Medico-Genetical Research Institute, Moscow*, Vol. 4, pp. 525-538, 1936. [Bibliography of 33 titles.] [In Russian with English summary.]

CONNOLLY, CORNELIUS J. The fissural pattern of the primate brain. *American Journal of Physical Anthropology*, Vol. 21, pp. 301-422, 1936. [Bibliography of 39 titles.]

GRAY, HENRY. Anatomy of the Human Body. Twenty-third Edition Thoroughly Revised and Re-edited by Warren H. Lewis. *Philadelphia* (Lea and Febiger), 1936. Pp. 1381. 10¼ × 6½ inches. $10.00. [Bibliography of indexes and journals, 41 titles: other bibliographies at end of various sections.]

LOO, Y. T. On nucleus geniculatus lateralis ventralis. *Chinese Journal of Zoology*, Vol. 2, pp. 31-38, 1936. [Bibliography of 11 titles.]

MURRAY, P. D. F. Bones. An Essay on the Development and Structure of the Vertebrate Skeleton. *Cambridge* (The University Press); *New York* (The Macmillan Co.), 1936. Pp. x + 190 + 8 plates. 7½ × 5⅜ inches. $2.50. [Bibliography of 8½ pages.]

### 2. *Physical Anthropology and Athropometry*

AMERICAN ASSOCIATION OF PHYSICAL ANTHROPOLOGISTS. Proceedings of the seventh annual meeting of the American Association of Physical Anthropologists: Institute of Human Relations, Yale University, New Haven, Connecticut, April 30, May 1 and 2. *American Journal of Physical Anthropology*, Vol. 21, No. 2 and Supplement, 1936. Pp. (of reprint) 19.

BUNAK, V. V. On some changes in mean values of characters in mixed populations. *Proceedings of the Maxim Gorky Medico-Genetical Research Institute, Moscow*, Vol. 4, pp. 237-253, 1936. [In Russian with English summary.]

BUNAK, V. V. The roles of heredity and environment in the structural variability of subcutaneous capillaries. *Proceedings of the Maxim Gorky Medico-Genetical Research Institute, Moscow*, Vol. 4, pp. 383-403, 1936. [Bibliography of 10 titles.] [In Russian with English summary.]

DREYER, T. F. The Florisbad skull in the light of the Steinheim discovery. *Zeitschrift für Rassenkunde*, Bd. 4, pp. 320-322, 1936. [Bibliography of 4 titles.]

GOUREVITCH, J. B. The roles of heredity and environment in the variability of heart measurements. *Proceedings of the Maxim Gorky Medico-Genetical Research Institute, Moscow*, Vol. 4, pp. 353-369, 1936. [Bibliography of 24 titles.] [In Russian with English summary.]

KROGMAN, WILTON M. The Physical Anthropology of the Seminole Indians of Oklahoma. With an Introduction by Corrado Gini. *Rome* (Comitato Italiano per lo Studio dei Problemi della Popolazione), 1935. Pp. xi + 199 + 39 plates. 10 × 7 inches. Lire 20 (paper). [Bibliography at end of some chapters.]

LUNDMAN, B. J. Raum und Typus in Süd- und Mittelschweden. *Zeitschrift für Rassenkunde*, Bd. 4, pp. 248-250, 1936. [Bibliography of 7 titles.]

MULLER, H. J. On the variability of mixed races. *Proceedings of the Maxim Gorky Medico-Genetical Research Institute, Moscow*, Vol. 4, pp. 213-236, 1936. [Bibliography of 10 titles.] [In Russian with English summary.]

PELLER, SIGISMUND. Wirtschaftskrise und körperliche Entwicklung der Kriegsgeborenen, derzeit im Pubertätsalter stehenden Jugend. *Klinische Wochenschrift*, Vol. 12, pp. 673-676, 1933. [Bibliography of 19 titles.]

ŠKERLJ, B. Die rassische Gliederung der Menschheit (Ein System zur Diskussion). *Zeitschrift für Rassenkunde*, Bd. 4, pp. 284-306, 1936. [Bibliography of 40 titles.]

SOBOLEVA, G. V., and M. V. IGNATIEV. The roles of heredity and environment in variability of height and weight. *Proceedings of the Maxim Gorky Medico-Genetical Research Institute, Moscow*, Vol. 4, pp. 370-382, 1936. [Bibliography of 19 titles.] [In Russian with English summary.]

WEIDENREICH, FRANZ. Observations on the form and proportions of the endocranial casts of *Sinanthropus pekinensis*, other hominids and the great apes: A comparative study of brain size. *Palaeontologia Sinica*, Series D, Vol. 7, Fasc. 4, 1936. Pp. 50.

WEIDENREICH, FRANZ. Über das phylogenetische Wachstum des Hominidengehirns. *Kaibôgaku Zasshi*, Vol. 9, Heft 5, 1936. Pp. (of reprint) 14.

### 3. *Constitution*

KRETSCHMER, ERNST. Körperbau und Charakter. Untersuchungen zum Konstitutionsproblem und zur Lehre von den Temperamenten. Elfte und zwölfte verbesserte und vermehrte Auflage. *Berlin* (Julius Springer), 1936. Pp. x + 243. 9¾ × 6½ inches. RM. 13.60. [Bibliographic footnotes.]

## V. PHYSIOLOGY AND BIOCHEMISTRY

### 1. *Physiology*

ANREP, G. V. Lane Medical Lectures: Studies in Cardiovascular Regulation. *Stanford University* (Stanford University Press), 1936. Pp. 118 + 14 plates. 10 × 7 inches. $1.50 (paper); $2.25 (cloth).

BENEDICT, FRANCIS G., and JOHN M. BRUHN. Chimpanzee metabolism. *Proceedings of the National Academy of Sciences*, Vol. 22, pp. 394-397, 1936. [Bibliography of 3 titles.]

CANNON, WALTER B. Digestion and Health. *New York* (W. W. Norton and Co.), 1936. Pp. 160. 8 × 5¼ inches. $2.00.

CLOWES, G. H. A., and M. E. KRAHL. Action of certain oxidative stimulants and depressants on respiration and cell division. *Report of the Dedication of the Lilly Research Laboratories*, October 12, 1934, pp. 73-79. [Bibliography of 15 titles.]

ELIOT, MARTHA M., DONALD J. BARNES, and RACHEL M. JENSS. A study of the comparative value of cod liver oil, viosterol, and vitamin D milks in the

prevention of rickets and of certain basic factors influencing their efficacy. *Journal of Pediatrics*, Vol. 9, pp. 355 ff., 1936. [Bibliography of 3 titles.]

FUNAOKA, SEIGO [Editor.] Arbeiten aus der dritten Abteilung des Anatomischen Institutes der Kaiserlichen Universität Kyoto. Serie D. Lymphatologie. Heft 5. Untersuchungen über die Physiologie der Lymphbewegung. Funktionen der Lymphdrüse. Physik, Chemie und Immunologie der peripheren Lymphe. Zellen der Lymphe. *Kyoto*, 1935-36. Pp. vi + 285 + 10 plates. 10½ × 7 inches (paper). [Bibliographic references throughout.]

LEAGUE OF NATIONS. The Problem of Nutrition. Volume I. Interim Report of the Mixed Committee on the Problem of Nutrition. *Series of League of Nations Publications.* II. *Economic and Financial* 1936. II.B.3. *Geneva* (League of Nations); *New York* (World Peace Foundation), 1936. Pp. 98. 9½ × 6¼ inches. 50 cents (paper). [Bibliographic footnotes.]

LEAGUE OF NATIONS. The Problem of Nutrition. Volume II. Report on the Physiological Bases of Nutrition drawn up by the Technical Commission of the Health Committee at the meeting in London (November 25th-29th, 1935), revised and amplified at the meeting held at Geneva (June 4th-8th, 1936). *Series of League of Nations Publications.* II. *Economic and Financial* 1936. II.B.4. *Geneva* (League of Nations); *New York* (World Peace Foundation), 1936. Pp. 27. 9½ × 6¼ inches. 15 cents (paper).

LEAGUE OF NATIONS. The Problem of Nutrition. Volume III. Nutrition in Various Countries. *Series of League of Nations Publications.* II. *Economic and Financial* 1936. II.B.5. *Geneva* (League of Nations); *New York* (World Peace Foundation), 1936. Pp. 271. 9¼ × 6¼ inches. $1.40 (paper).

LEAGUE OF NATIONS. The Problem of Nutrition. Volume IV. Statistics of Food Production, Consumption and Prices. Documentation Prepared by the International Institute of Agriculture. Presented to the Mixed Committee on the Problem of Nutrition at Its Second Session, June 4th, 1936. *Series of League of Nations Publications.* II. *Economic and Financial* 1936. II.B.6. *Geneva* (League of Nations); *New York* (World Peace Foundation), 1936. Pp. 110. 10½ × 8 inches. 75 cents (paper).

LIBERSON, W. Métabolisme et Obésité. Publications du *Travail Humain* Série A. No. 7. *Paris* (Conservatoire National des Arts et Métiers), 1936. Pp. 157. 10 × 6½ inches. 25 francs (paper). [Bibliography of 125 titles.]

LIPSCHÜTZ, ALEXANDRE. Différences préhypophysaires spécifiques du sexe, chez l'homme. *Comptes rendus des séances de la Société de Biologie*, Vol. 121, pp. 208-211, 1936. [5 bibliographic footnotes.]

MCCANCE, R. A., E. M. WIDDOWSON, and L. R. B. SHACKLETON. The Nutritive Value of Fruits, Vegetables and Nuts. *Medical Research Council, Special Report Series*, No. 213. *London* (H. M. Stationery Office), 1936. Pp. 107. 9⅝ × 6⅛ inches. 2s. net (paper). [Bibliography of 6 pages.]

PELLER, SIGISMUND, and ILSE ZIMMERMANN. Über Faktoren, welche die Zeit der Erstmenstruation bestimmen. *Zentralblatt für Gynäkologie*, Vol. 57, pp. 2897-2909, 1933. [Bibliographic footnotes.]

RAJZMAN, ANNA. La valeur biologique des protéines: Fixité ou variabilité interspécifique. *Archives Internationales de Physiologie*, Vol. 43, pp. 351-396, 1936. [Bibliography of 17 titles.]

RAJZMAN, ANNA. Le métabolisme comparé de l'azote et du soufre dans la supplémentation. *Archives Internationales de Physiologie*, Vol. 43, pp. 397-422, 1936. [Bibliography of 22 titles.]

RAJZMAN, ANNA. Action dynamique spécifique et activité rénale. *Archives Internationales de Physiologie*, Vol. 43, pp. 423-448, 1936. [Bibliography of 12 titles.]

RENQUIST-REENPÄÄ, YRJÖ. Allgemeine Sinnesphysiologie. Stellung und Bedeutung des Sinnesphysiologischen Versuches im Bereich der Observation, des exakten Experimentes und der Begriffsbildung. *Vienna* (Julius Springer), 1936. Pp. v + 160. 9¼ × 6¼ inches. RM. 12 (paper). [Bibliography of 5 pages.]

SPENCE, K. W., and J. F. FULTON. The effects of occipital lobectomy on vision in chimpanzee. *Brain*, Vol. 59, pp. 35-50, 1936. [Bibliography of 17 titles.]

[STARLING, ERNEST H.] Starling's Principles of Human Physiology. Seventh Edition. Edited and Revised by C. Lovatt Evans. The Chapters on the Central Nervous System and Sense Organs Revised by H. Hartridge. *Philadelphia* (Lea and Febiger), 1936. Pp. xiii + 1096. 9⅜ × 6 inches. $8.75. [Extensive bibliography throughout.]

TERROINE, ÉMILE F. La part protéique dans l'alimentation humaine. *Bulletin Trimestriel de l'Organisation d'Hygiène de la Société des Nations*, September 1936. Pp. (of reprint) 75.

TERROINE, ÉMILE F. La répartition des représentants urinaires du métabolisme azoté et sa signification physiologique. VIII. Les règles fondamentales de l'étude du catabolisme azoté. *Bulletin de la Société de Chimie biologique*, Vol. 18, pp. 665-686, 1936. [Bibliography of 30 titles.]

TERROINE, ÉMILE F., and CONSTANTIN LAURESCO. Travail digestif et catabolisme purique endogène. *Archives Internationales de Physiologie*, Vol. 42, pp. 461-472, 1936. [Bibliography of 7 titles.]

TERROINE, ÉMILE F., ROBERT BONNET, and GILBERTE MOUROT. Les causes de la créatinurie. *Archives Internationales de Physiologie*, Vol. 42, pp. 381-397, 1936. [Bibliography of 20 titles.]

VERZÁR, F., assisted by E. J. MCDOUGALL. Absorption from the Intestine. *New York* (Longmans, Green and Co.), 1936. Pp. xii + 294 + 12 plates. 8¾ × 5⅞ inches. $9.00. [Bibliography of 30¼ pages.]

ZONDEK, BERNHARD. Hormone des Ovariums und des Hypophysenvorderlappens. Untersuchungen zur Biologie und Klinik der Weiblichen Genitalfunktion. Mit einem Anhang: Hormonale Schwangerschaftsreaktion. Hormon des Hypophysenzwischenlappens. Zweite vermehrte Auflage. *Berlin* (Julius Springer), 1935. Pp. xi + 638. 9¾ × 6¼ inches. RM. 58 (paper); RM. 59.80 (cloth). [Extensive bibliography throughout.]

### 2. *Senescence, Senility and Longevity*

FREUND, ERNEST. Was können wir von der Lebensweise der Neunzigjährigen lernen? *Wiener klinische Wochenschrift*, Bd. 49, pp. 809-810, 1936.

PEARL, RAYMOND, and JOHN R. MINER. Life tables for the pecan nut case bearer, *Acrobasis caryae* Grote. *Mémoires du Musée Royal d'Histoire Naturelle de Belgique. Deuxième Série*, Fasc. 3. (Mélanges Paul Pelseneer), pp. 169-184, 1936. [Bibliographic footnotes.]

### 3. *Biochemistry*

ALLEN, EDGAR, A. W. DIDDLE, T. H. BURFORD, and J. H. ELDER. Analyses of urine of the chimpanzee for estrogenic content during various stages of the menstrual cycle. *Endocrinology*, Vol. 20, pp. 546-549, 1936. [Bibliography of 20 titles.]

BARBARO-FORLEO, GIUSEPPE. Il Glutatione. Sua Importanza nella Biologia Generale e nella Fisiopatologia Umana. Preface by Luigi Zoja. *Pavia* (Tipografia già cooperativa), 1936. Pp. xiv + 449. 10 × 7 inches. 30 lire (paper). [Bibliography of 22 pages.]

BONNET, ROBERT, and BERTHE NATAF. Sur la destruction de certaines diastases hydrolysantes au cours de leur action. *Bulletin de la Société de Chimie biologique*, Vol. 18, pp. 615-635, 1936. [Bibliography of 15 titles.]

BONNET, ROBERT and ROBERT RAZAFIMAHERY. Sur la spécificité de l'uréase. *Enzymologia*, Vol. 1, pp. 55-59, 1936. [Bibliography of 12 titles.]

BURRIN, P. L., A. G. WORTON, and F. E. BIBBINS. Compound solution of cresol — the variation of phenol coefficient when different oils are used for saponaceous base. *Journal of the American Pharmaceutical Association*, Vol. 24, pp. 1077-1079, 1935. [Bibliography of 3 titles.]

BURRIN, P. L., A. G. WORTON, and F. E. BIBBINS. Evaluation of a deterioration factor in liquid petrolatum. *Journal of the American Pharmaceutical Association*, Vol. 25, pp. 27-31, 1936. [Bibliography of 5 titles.]

FLATTER, M. Le taux des acides gras des monoaminophosphatides. *Bulletin de la Société de Chimie biologique*, Vol. 18, pp. 406-413, 1936. [Bibliography of 11 titles.]

HARRIS, ISAAC F. Occurrence, Uses and Essays of the Water-Soluble Vitamin-$B_1$ and Vitamin-$B_2$ or G-Complex. *Tuckahoe, New York* (Harris Laboratories), 1936. Pp. 62. 10 × 7 inches (paper). [Bibliographic footnotes.]

LOO, Y. T. The thymo-nucleic acid in normal nerve cells. *Chinese Journal of Zoology*, Vol. 2, pp. 1-16, 1936. [Bibliography of 9 titles.]

MOUROT, GILBERTE. La production synthétique des composés créatiniques au cours de l'inanition protéique. *Bulletin de la Société de Chimie biologique*, Vol. 18, pp. 1513-1523, 1936. [Bibliography of 10 titles.]

POWELL, H. M., and W. A. JAMIESON. Preparation of the Krueger undenatured bacterial antigens. *Journal of Laboratory and Clinical Medicine*, Vol. 21, pp. 301 ff., 1935. [Bibliography of 8 titles.]

SOCIETY OF BIOLOGICAL CHEMISTS. Biochemical and Allied Research in India in 1935. *Bangalore, India* (Society of Biological Chemists), 1936. Pp. 130. 8½ × 5½ inches (paper). [383 bibliographic references.]

### 4. *Pharmacology*

CHEN, K. K., EDWARD E. SWANSON, E. C. KLEIDERER, and G. H. A. CLOWES. Ergotocin, ergometrine, ergostetrine and ergobasine. *Journal of Pharmacology and Experimental Therapeutics*, Vol. 57, pp. 74-80, 1936. [Bibliography of 32 titles.]

GADDUM, J. H. Gefässerweiternde Stoffe der Gewebe. Introduction by H. H. Dale. *Leipzig* (Georg Thieme), 1936. Pp. xii + 200. 9¾ × 6½ inches. RM. 18 (paper); RM. 20 (cloth). [Bibliography of 29 pages.]

## VI. PATHOLOGY, CLINICAL MEDICINE AND SURGERY

BENTLEY, F. J. Artificial Pneumothorax: Experience of the London County Council. *Medical Research Council; Special Report Series* No. 215. *London* (H. M. Stationery Office), 1936. Pp. 94. 9⅝ × 6⅛ inches. 1s. 6d. net (paper). [Bibliography of 100 titles.]

BERNARD, IRÈNE. Plastique Mammaire. Considérations médico-chirurgicales. *Paris* (*Librairie Maloine*), 1936. Pp. 245. 10 × 6½ inches. 40 francs (paper). [Bibliography of 55 titles.]

FEARON, WILLIAM R. Nutritional Factors in Disease. *London* (William Heinemann), 1936. Pp. xiv + 141. 8½ × 5¼ inches. 7s. 6d. net. [Bibliography of 268 titles.]

MEDICAL RESEARCH COUNCIL. Medical Uses of Radium. Summary of Reports from Research Centres for 1935. *Medical Research Council, Special Report Series*, No. 216. *London* (H. M. Stationery Office), 1936. Pp. 38 + 5 plates. 9⅝ × 6 inches. 1s. net (paper).

MILLS, C. A. The intestinal toxemia syndrome. *Journal of Laboratory and Clinical Medicine*, Vol. 20, p. 801, 1935. [Bibliography of 3 titles.]

POWELL, H. M., W. A. JAMIESON, and G. F. KEMPF. On the relation of heterophile antigen to serum sickness. *Journal of Immunology*, Vol. 29, pp. 267-272, 1935. [Bibliography of 8 titles.]

WAREMBOURG, HENRI. Les Hyperglycémies. Étude Clinique et Physiopathologique. Preface by Professors Loeper and Polonovski. *Paris* (Masson et Cie), 1936. Pp. xiii + 584. 10 × 6½ inches. 65 francs (paper). [Bibliography of 55 pages.]

## VII. METHODOLOGY

### 1. *Mensurational and Observational*

DICE, LEE R., and ARNOLD J. LERAAS. A graphic method for comparing several sets of measurements. *Contributions from the Laboratory of Vertebrate Genetics, University of Michigan*, No. 3, 1936. Pp. (of reprint) 3.

### 2. *Mathematical and Statistical*

BUREAU OF THE CENSUS. Instruction Manual. Procedure and Rules used in the Division of Vital Statistics for Coding Mortality Transcripts and Punch-

ing Machine Tabulation Cards. *Division of Vital Statistics, Washington, D. C.*, November 15, 1936.

CONRAD, HERBERT S., and GEORGE B. MARTIN. The index of forecasting efficiency, for the case of a "true" criterion. *Journal of Experimental Education*, Vol. 4, pp. 231-244, 1936. [Bibliography of 14 titles.]

DAVENPORT, C. B., and MERLE P. EKAS. Statistical Methods in Biology, Medicine and Psychology. Fourth Edition, Completely Revised. *New York* (John Wiley and Sons); *London* (Chapman and Hall), 1936. Pp. xii + 216. 7 × 4⅜ inches. $2.75.

FISHER, IRVING. Note on a short-cut method for calculating distributed lags. XXIII° *Session de l'Institut International de Statistique, Athènes*, 1936. Pp. (of reprint) 6.

FISHER, R. A. Statistical Methods for Research Workers. Sixth Edition — Revised and Enlarged. *Edinburgh* (Oliver and Boyd), 1936. Pp. xiii + 339 + 6 folding tables. 8¾ × 5½ inches. 15s. net. [Bibliography of 7½ pages.]

KOSTITZIN, V. A. Sur les équations différentielles du problème de la sélection mendélienne. *Comptes rendus des séances de l'Académie des Sciences*, Vol. 203, pp. 156-157, 1936.

KULLBACK, SOLOMON. On certain distribution theorems of statistics. *Bulletin of the American Mathematical Society*, June 1936, pp. 407:410. [Bibliographic footnotes.]

LEVY, H., and L. ROTH. Elements of Probability. *New York* (Oxford University Press), 1936. Pp. x + 200. 8¾ × 5½ inches. $5.00. [Bibliographic footnotes.]

NEYMAN, J., and E. S. PEARSON. Sufficient statistics and uniformly most powerful tests of statistical hypotheses. *Statistical Research Memoirs*, Vol. 1, pp. 113-137, 1936. [Bibliographic footnotes.]

WISHART, J. Tests of significance in analysis of covariance. *Supplement to the Journal of the Royal Statistical Society*, Vol. 3, pp. 79-82, 1936. [Bibliography of 6 titles.]

WISHART, J., and H. O. HIRSCHFELD. A theorem concerning the distribution of joins between line segments. *Journal of the London Mathematical Society*, Vol. 11, pp. 227-235, 1936. [Bibliographic footnotes.]

### 3. *Other and General*

BARNARD, J. E., and FRANK V. WELCH. Practical Photo-Micrography. *New York* (Longmans, Green and Co.); *London* (Edward Arnold and Co.), 1936. Pp. xii + 352 + 23 plates. 8½ × 5⅜ inches. $8.25.

TRELEASE, SAM F., and EMMA S. YULE. Preparation of Scientific and Technical Papers. Third Edition. *Baltimore* (Williams and Wilkins Co.), 1936. Pp. 125. 7¼ × 5 inches. $1.50.

## VIII. GENERAL AND MISCELLANEOUS

INDIAN RESEARCH FUND ASSOCIATION. Proceedings of the Thirteenth Medical Research Workers Conference, held at Calcutta from 2nd to 7th December,

1935. Appendix to the Technical Report of the Scientific Advisory Board for the Year 1935. *New Delhi*, 1936. Pp. 91. 9¾ × 6¼ inches (paper).

INDIAN RESEARCH FUND ASSOCIATION. Report of the Scientific Advisory Board for the Year 1st April, 1935 to the 31st December, 1935. *New Delhi-Simla, India* (Indian Research Fund Association), 1936. Pp. v + 167. 9¾ × 6¼ inches. One rupee (paper).

JEANS, SIR JAMES, SIR WILLIAM BRAGG, E. V. APPLETON, EDWARD MELLANBY, J. B. S. HALDANE, and JULIAN HUXLEY. Scientific Progress. Sir Halley Stewart Lecture, 1935. *New York* (The Macmillan Co.), 1936. Pp. 210 + 4 plates. 7¾ × 5½ inches. $2.00.